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CONTENTS

Annual Address of the President. By Leonard Metcalf 267
Recent Progress and Tendencies in Municipal Water Supply in the United States. By John W. Alvord..... 278
Discussion..... 295
Relations Between Water Departments, Companies and the Public. By W. C. Hawley..... 300
Relations Between a Water Department and the Public. By A. A. Reimer..... 306
The Service Charge—How Constituted. By J. N. Chester..... 313
Discussion..... 320
The Relation of the Railroad to the City Water Plant. By C. R. Knowles..... 326
Discussion..... 329
Forty-five Years' Experience in Water Works. By E. E. Davis..... 332
The Chlorine Cell Installation of the Montreal Water and Power Company. By F. H. Pitcher and James O. Meadows..... 337
Discussion..... 345
Pumping Station Cost and Efficiency Records. By Mark Wolff..... 347
Troubles in Constructing a 48-inch Submerged Main. By F. W. Cappelen..... 355
Seeking Better Insurance Classification for Small Cities. By C. M. Roos..... 363
The Economy of Meters. By C. L. Köhn..... 368
Value of Laboratory Control of Operation of Water Purification Plants..... 372
Report of the Committee on Water Consumption..... 378
Report of the Committee on Prevention of Stream and Lake Pollution..... 383
Reports of the Committee on Electrolysis..... 386
Report of Committee on Revision of Standard Specifications for Cast Iron Water Pipe and Special Castings 389
Society Affairs..... 395

THEODORE A. LEISEN, PRESIDENT 1917–1918

JOURNAL

OF THE

AMERICAN WATER WORKS ASSOCIATION

The Association is not responsible, as a body, for the facts and opinions advanced in any of the papers or discussions published in its proceedings.

VOL. 4 SEPTEMBER, 1917 No. 3

ANNUAL ADDRESS OF THE PRESIDENT[1]

By Leonard Metcalf

The thirty-seventh annual convention of the American Water Works Association meets in an active, growing community, rich in past traditions, at a time when vital history is in the making the world over, as never before in the memory of the present generation. It will be looked back upon as a period of regeneration, a modern renaissance.

Everywhere men are outwardly asking one another, "What can I do to help?" and inwardly are asking themselves the soul-searching question, "Am I rendering my fellow-men full measure of service commensurate with my capacity?" From top to bottom of the social structure, from the very government itself to the source of its power, the individual, underlying principles and current practice in the conduct of affairs are under review and are feeling the effect of constructive criticism; while an appalling price in life, in suffering and in treasure, is being paid to determine by war the relative advantage and danger of the development of the individual as a unit, with subservient democratic government, or of the highly-centralized autocratic government, with a dependent people.

Under such conditions it is fitting that this Association, too, should pause at this time to consider whether it is meeting its full duty to the public and is filling and cultivating its field as thoroughly

[1] Read before the thirty-seventh annual convention of the American Water Works Association, Richmond, Va., May 7, 1917.

as possible and, if not, what it can do to render larger measure of service. Let us review the situation briefly.

The membership of the Association, about 1300 in number, is scattered from the eastern to the western seaboards, and from the southern limits of the United States to Canada. Yet in many states the membership is very small and scattered and many of the cities and towns of the country have no representation. As compared with those of other national organizations, such as the membership of the American Society of Civil Engineers, 8200; the American Society of Mechanical Engineers, 7700; the American Institute of Electrical Engineers, 7600; and the American Institute of Mining Engineers, 5900; our numbers are totally inadequate. Even as compared with the membership of other water works organizations, our membership is not as comprehensive as it should be.

The field is a broad one. The administrative problems of water works property involve many important questions of policy and relations with the public, and legal and financial, as well as administrative, questions. The operating department deals in its sources of supply and reservoirs, with problems touching the fields of sanitary science, chemistry, biology, bacteriology, agriculture, forestry and others; in its pumping stations, with mechanical and electrical engineering; in its pipe system, with geology, metallurgy, labor and manufacture. The accounting department deals with legal, commercial and mechanical problems. The construction department with problems in civil, mechanical, electrical, mining, chemical, and physical engineering.

No wonder, then, that there is felt in the water works field the influence of the overlapping of other societies. Nevertheless, we should strive to reach and serve the general practitioner—the practically trained man, rather than the highly educated or technical one, occupying a highly specialized position—to give to this large class of capable, intelligent, industrious and able men the opportunity not only to get together in annual convention, but to assist in developing and advancing the state of the art in their particular fields of activity.

Are we doing this? In some measure, yes, as a fair comparison of the last with any earlier decades clearly indicates. In full measure, no. The reason is easily found. It is the essential problem of the national society, whatever its field of activity. It is two-fold in nature, due first to the widely scattered membership,

making frequent intercourse about a common board impossible, and second, to lack of financial resources, conducing to the same end.

But are we content to let this continue; to let the timid man, the complaisant man, yes, even the busy man, remain indifferent to the fact, that others pass us while we linger by the way, more happy then helpful, and fail to interest in the fundamental, and often as yet undeveloped, truths of our science, the water works men whom we do not reach, do not arouse, do not vitalize, and who are unfortunately in the great majority? As individuals we are no less responsible, no less willing to do our full duty than others, but unfortunately collectively the burden of responsibility is not only less noticeable but less heeded. The primary difficulties seem to me to lie in the lack of unity of purpose and in the committee work, largely in the lack of method and of accomplishment in such work.

The lack of unity of purpose is the direct result of difference in local conditions and problems, difference in point of view, and most important, the remoteness of many members, making it practically impossible to get together to discuss pending issues face to face.

The local organizations in any profession or calling have an advantage over those of national membership in that they afford greater opportunities for personal touch and discussion. It is much better to talk over disputed subjects than to write about them, for there are always opportunities for misunderstanding the exact meaning of letters, and persons who really hold quite similar views may unwittingly mislead each other through this tendency of all correspondence. When there are real differences of opinion, and these can be settled only by prolonged study and exchange of views, letter writing is a handicap from which national societies suffer far more than local societies and is largely the cause of lack of perfect harmony in this and other associations.

There will always be differences of opinion regarding the work of our Association, just as there are similar differences in every live organization. The free and frank discussion of such differences is helpful not detrimental, for it enables the policy of the Association to be laid along the lines which will make it most effective in its primary purpose, the improvement of the administration of water works. The difficulty which has been facing this organization is the feeling that the discussions have not always been free and frank.

Some of its members are inclined to believe that the officers, whom they have elected for duties specifically stated in the Constitution, have exceeded their authority, or that a little clique of a few members in one section of the country or another is playing petty politics for its own advantage, without regard for the welfare of the organization, or that some of the work of the Association is not carried on in the manner which best meets the needs of the members. Probably every member can recall cases where he has been misled by letters from friends about personal matters and these misunderstandings would have been serious if friendship did not convince him that there was something wrong about the correspondence.

There are just two features of the administration of national societies about which there can be no real argument. The first is that the duties of the different officers and committees must be clearly defined and not overlap, so that there can be no question as to the responsibility for each function of the society. The second feature is that every officer and committee must clearly recognize the limitations to freedom of judgment. These spheres of responsibility must be thoroughly recognized by each officer and committeeman and they must coöperate freely and fully. The very fact that an organization is national in membership makes the responsibilities of these men greater and calls for more careful, friendly and sympathetic treatment of their mutual relations. The methods that serve in local organizations will fail in a national organization unless they are used with great care. Persons who may try to use the Association to their advantage will naturally foster every trivial misunderstanding between officers, in order that out of the friction which they help to create, they may gain their ends. The history of the American Water Works Association, as of other societies, is marred by the unfortunate results of lack of complete coöperation between its officers, its committees and its members. It is difficult to avoid this condition when busy men must give a large amount of time to Association affairs, but a great deal can be accomplished if each member, whether officer, committeeman or serving for the time in the ranks, will adopt a policy of hearty coöperation instead of criticism.

It is full time for everybody in the Association to realize that differences of opinion do not necessarily mean any personal likes or dislikes. We may differ from our friends on many things and still

like them just as much as if we agreed with them. The members of the Association form a large family, in which the majority decides what shall be done. As in most organizations which have weathered days when disaster was imminent, the members have learned that it is best to give large powers to the officers, because a few men can consult together more easily than many and carry on business better in every way. The steady increase in the growth of the Association and the improvement in its financial condition since the old days, when it was without much standing and was in perpetual financial straits, bear clear testimony to the skillful management of the Association's affairs since the New Orleans convention, when it was decided by the members that sound business methods should be substituted for those previously followed from the founding of the society. The difficulties attending this task were many and have not yet all been overcome; they called for self-sacrifice of time by many of the most busy members, but this sacrifice was gladly made in the belief, which has been justified by the results, that the American Water Works Association could be made a strong, influential body.

The elimination of this lack of complete harmony or unity of purpose can be accomplished by individual determination to overlook personalities in the absorbing interest of the problem and to better the past methods of carrying on committee work, which have often prevailed.

As one looks back through the files of different technical associations, one is always struck by certain committee reports and papers by individuals, as marking epochs or periods in the progress of science, papers that have stood unchallenged as fair exponents of truth, for years, sometimes for decades; while many others are of little lasting value, though they may have served a useful temporary purpose. From time to time there come periods and problems in our field, as in world politics, when the opportunity is afforded to develop new truths or to sum up the state of the art in a useful manner. The breadth of the membership, the great variation in conditions, and hence of results, in the wider field of the entire country as compared with the state, county, or municipality, give to such an organization as this, and to its committees, a breadth of comparative experience from which to draw, of incomparably greater value than the sources available to any ordinary individual located in any one spot, and carry with this greater opportunity, larger

responsibilities and obligations to serve. But to draw out, assemble, analyze, digest and present the resulting significant truths, involves a task of magnitude: work, much, hard, sound, self-sacrificing work, all along the line. But it is a cheerful, productive work, bringing not only the joy of real discovery and of intellectual attainment, but also happy friendships and confidential relations. One has a different feeling for men with whom one had gone on voyages of scientific discovery or fought intellectual battles, from those with whom one has had but passing acquaintance.

Has committee work in this Association always been approached in this serious vein? Have we given to committee work the careful and conscientious thought and labor which it deserved? Have we always had the broad, sound and well-considered reports, which we have had a right to demand? I submit, no, and I say it with deep regret, with a full appreciation of the difficulties inherent in the task and in the position of the busy individuals involved; and without prejudice to some excellent work which has been done in the past by individuals and committees in this society. Nevertheless, we should face the facts, draw our conclusions, and point the remedy.

Is it not true that we have had many committees continued from year to year, making little or no effort to act or even to accumulate evidence between conventions, and accomplishing but little? Contrast this with the constructive, productive and valuable work of the committees of the American Railway Association, of the Society for Testing Materials and others, or with the work of some other committees of our own. For example, I chance to know of a committee to which was entrusted a report upon a very comprehensive, controversial, and difficult subject, which in a period of five years held nearly fifty all-day and frequent night working sessions. The members, coming from widely scattered points at marked personal sacrifice in time, convenience and money, carried on in manifold (so that all committee members might follow discussions between its individual members) a correspondence covering literally thousands of pages of typewritten matter. This committee wrote and rewrote several of the chapters of its report over and over again, but finally came to common ground—though its members were of widely different training, experience and practice—and presented a comprehensive and well-studied report. Such efforts *must* be productive of good, particularly where there stands back of the committee

such a tremendous storehouse of information as the individual members of this association in the aggregate represent.

It is clear that the work of the Association must of necessity be done largely through its committees. The past experience of all societies has demonstrated this, and, after all, the success of committee work must depend upon the attitude and enthusiasm of committee members. Active, alert committee-men are indispensable to success.

May we not, then, demand such service? We have the right. We need only the determination. Once it is realized that this Association demands such service and will set its seal of approval on no other, it will get it, for men are ever ready to serve under a high standard and where creative work is the first aim.

We would do far better not to appoint committees to unattainable, undefined, difficult tasks, than to tolerate a drifting, do-nothing policy.

Our difficulties in the past, which find parallel in many societies, in our legislative bodies and in American society at large, are to be explained readily through distance between members, lack of understanding, unfamiliarity with committee work or want of initiative, but none of these difficulties is insurmountable. The American Society of Civil Engineers has recently been through like experiences and was finally driven to curtailing, directing in some cases, and following up its committee work in others, and these things were done with good result.

The solution of this particular difficulty in our Association may lie in the suggestions that:

First, we develop better team play;

Second, the committees have their allotted work more clearly defined;

Third, the committees be made to appreciate their opportunities and sources of information, as well as their obligations to the Association;

Fourth, the committees be instructed to carry on all correspondence between individual members of the committee in manifold, that is, by sending carbon copies of all committee letters, reports, data or discussions, to all members of the committee;

Fifth, the committees be required to report meetings and progress quarterly, or as often as circumstances may make desirable, to the Secretary of the Association;

Sixth, The President and Editor be kept advised by the Secretary from time to time of progress in committee work. Our valued fellow-member, M. N. Baker, associate editor of *Engineering News-Record*, has recently raised the significant question, "Should not important committee reports, adopted by the Association, be given the added weight of the active support, which would result from submitting such adopted reports to letter-ballot of the Association?" The suggestion has merit, though it is not without danger of abuse. It is in line with the present-day growing belief that our engineering societies should take a more active part in moulding public opinion, within their own fields of activity, rather than to stand aloof from such causes, as heretofore, because of fear of perverse use of the power of the society, or other reason. Action involves danger, it is true, but inaction involves loss of power. It is better to grow strong in action, at the expense of occasional failure, than to lose the power to act and be forced to let less-experienced men than our association affords, determine desirable policies within the field in which our members are the better informed.

The interrelation of any national society with its local sections is a most important one. Much study is being given today by all of the national societies, as indeed by our American universities and large industrial establishments, to the problem of determining the best manner for keeping the sections closely in touch with the work of the parent organization. It is a difficult task. To this end it is desirable to have all important section meetings attended by some member of the Executive Board of the main association. Clearly the work of the sections should in general be local in character. The broader problems, involving wide range in conditions, should be reserved for discussion before the parent association. It in turn owes the obligation to discriminate clearly between new live matter to which its attention should be directed and the smaller problems of more local interest; and to reduce the amount of redundant, cumulative, or purely descriptive matter in its *Journal*, to a minimum, not only on the score of saving in expense of publication, but more important yet, to conserve, as far as possible, the time of the readers.

The Association labors under the great disadvantage of all organizations of limited membership and small income, namely, that it is not possible to carry on its work with the efficiency attainable in a large organization.

It will probably be impossible for this Association to do its best work until it has permanent headquarters with an adequately paid secretary devoting his entire time to the work of the organization. At present, with its limited membership, that is impracticable; but when it comes it will make possible a closer following-up of committee work and it is to be hoped will provide financial aid in the form of traveling expenses, secretarial assistance to committees, and aid in the carrying on of research work. Nevertheless, there can be no doubt that meanwhile, busy as most of our members are, they and their works can be counted upon for larger measure of service than has been rendered heretofore, and even service involving financial outlay or burden, to the end of having more significant reports and extending the usefulness of the Association.

As time goes on it seems likely that some of the bureaus of municipal research may aid in developing practical men who can assist effectively in committee or secretarial work, and coöperative effort between different societies may be productive of fewer and less conflicting standards.

With reference to the conduct of the conventions, a few words of suggestion may not be out of place. Time could profitably be saved by delegating to a committee of the Executive Board, the determination of the place for holding the annual convention.

Many papers could be presented in outline, reserving, at the discretion of the Executive Committee, a larger amount of time for the complete presentation of the most important papers or committee reports. Concentration upon one or two important subjects, giving in effect a symposium upon these subjects, would probably be productive of material better for the *Journal* and of greater value to water works men. While breadth of interest is desirable and ample opportunity should always be given for experience talks, diversity of subjects discussed inevitably leads to dispersion of energy.

While it is certainly desirable that the conventions should be made attractive to the families and friends of members, and some play for members themselves may be welcome, a spirit of serious work should characterize the sessions. With such a spirit dominating, work will automatically replace play when matters of importance press and when material properly presented is offered. These influences will immediately make themselves felt in the *Journal* of the Association. Furthermore, there can be no doubt

that the maintenance of a high standard of publication will stimulate greater care on the part of authors, to the marked advantage of the membership. Serious scrutiny of papers by a well-qualified editor, under the general direction of a committee on publications, is much to be desired, and will do much to conserve the time of members.

An orderly arrangement of the convention schedule, and punctuality in attendance upon the meetings, is also important.

Present conditions demand that I call pointedly to your attention the obligation of the managers of the water works of this country, both municipal and privately owned, to aid in giving the public service commissions or other regulatory bodies, a just appreciation of the financial difficulties in which many water works now find themselves, as a result of rapid advance in wages, cost of materials and standards of service, for some time past, acutely aggravated by present war conditions. Water works properties have for years been less attractive for investment than the stable nature of their business should have made them, essentially because of inadequate return, or at least unattractive profit. The profit item has gradually been reduced, in many cases to the vanishing point, by the influences cited, coupled with the growing cost of litigation and proof of fundamental value, as is well known to you water works men. Now comes the added burden of high prices induced by war conditions, which is sweeping away depreciation allowances and reserves and resulting in a declining service. Men familiar with such matters view with deep anxiety the failure of regulating bodies to recognize the inevitable result of this condition and to govern their actions accordingly. Later on, the public will make felt its protest against a declining service, in no uncertain terms. Present inaction is as disadvantageous to the public as to the private interest. The way in which it is felt differs only in time, the ultimate inconvenience, annoyance and positive loss being common to both.

With wage increases of from 15 to 30 per cent in the last few years, and advances in cast iron pipe from $25 to $55 per ton, lead from 5 to 10 cents, copper from 13 to 30 cents, steel products and coal more than 100 per cent, cement from $1.25 to $2.50 per barrel, and machinery not only doubled in value but impossible of prompt and reasonable delivery, it is clear that capital cannot be induced to extend the service without substantial relief of some sort.

Therefore I say to you, join one another in presenting the actual facts convincingly to the authorities wherever occasion requires relief, that the public service may not be impaired through lack of knowledge on the part of the governing bodies. The position of these bodies or commissions is at best most difficult, particularly under such conditions as now prevail, and they are deserving of all the assistance that we can give them, as the problem is a vital one and essentially one of public education.

In conclusion I want to express to you, officers, executive board, committees and members of this Association, the pleasure which I have had in working with you, and my appreciation of the friendly coöperation which you have given me, and to disclaim any personal animus in the suggestions contained in this address. It is in no idle or superficial manner that I speak, but rather with conviction and the desire to offer constructive criticism in the friendliest spirit. We are all looking toward the future, to higher ideals, better service and a wider field of activity for the American Water Works Association.

RECENT PROGRESS AND TENDENCIES IN MUNICIPAL WATER SUPPLY IN THE UNITED STATES[1]

By John W. Alvord

It is often worth while to turn from the immediate and exacting problems that absorb our attention from day to day and pause to survey our accomplishments and review briefly the progress we have made. Particularly is it a pleasure to summarize progress in the important field of municipal water supply engineering, where the advancement of the art has been most gratifying in recent years and where new prospects have been opened up for further improvement and service to the public.

About one hundred years have elapsed since the pioneer water-works plants in this country were first put in operation. The intervening century has witnessed a very remarkable concentration of urban population, which has greatly stimulated and been in large measure conditioned upon the extensive growth of our now great municipal water supply systems, and with the spread of modern habits of life and enterprise a multitude of smaller water works plants have sprung up all over the country, until all but the very smallest communities now enjoy the benefits of a public water supply.

These conditions have created a large field for the development and exploitation of methods and equipment for water supply, but have not as yet resulted in any considerable degree of standardization of water works practice. Evolution of our water-works systems and of water works practice is still in progress. A great deal has been accomplished, especially in the last ten or fifteen years, to make our public water supplies all that they should be, but much still remains to be done. The progress of the past few years has been mainly in the direction of the development of new supplies on unprecedented scale, radical new methods of water purification, new developments in pumping machinery and measures to reduce water waste. It is the purpose of this paper to briefly review this recent progress and to point out present tendencies.

[1] Read before the Richmond convention, May 8, 1917.

DEVELOPMENT OF WATER SUPPLY SOURCES

With continued growth all of our larger cities have found it necessary in recent years repeatedly to make large additions to their water supplies.

The cities most favorably situated to keep pace with the endless demand for water in increasing quantity are those bordering on the Great Lakes and on our larger rivers, where it has only been necessary to increase the pumping capacity to get more water. But the quality of the water has complicated this otherwise simple problem, and even our lake cities have found increasing embarrassment in this direction. In the attempt to eliminate turbidity and secure more uniformly potable and safe water, the larger cities have extended their intakes further from the shores and to greater depth of water. In the past few years Cleveland, Chicago and Milwaukee have all sought this costly solution of their water problem, with indifferent success. Cleveland has finally adopted filtration, Chicago sterilizes its water and Milwaukee must come to filtration if it is to have a safe and satisfactory water. With the increasing pollution of the lakes, and the growing demand for pure, clear water at all times, the tendency of thought is towards the filtration of lake supplies. Many of the smaller cities, including Sandusky and Lorain, Ohio, Erie, Pa., and more recently Niagara Falls, N. Y.; Evanston, Ill.; South Milwaukee, Wis.; Bay City, Mich.; East Chicago, Ind., and others have adopted filtration.

The water supply problem of our large river cities has continued to be a comparatively simple one in point of quantity but has presented increasing difficulties, mainly by reason of the very general and rapidly increasing pollution of most of our streams. In the face of these difficulties, the past twenty years and particularly the decade just past have witnessed an immense improvement in quality of the more important river city supplies, following the introduction of filtration. Since the pioneer application of filtration on a large scale at Louisville, important river cities, including New Orleans, St Louis, Kansas City, Minneapolis, Evansville, Pittsburgh, Philadelphia and Washington, and many smaller cities, have introduced filtration of their water supplies within the past few years.

It is among impounded and gravity supplies that we find the most notable water supply developments recently constructed or under

way. These include the great new gravity supplies for New York, Los Angeles and San Francisco. The great dams and aqueducts of the Catskill supply for New York, at an estimated cost of about $200,000,000, will provide an additional 200,000,000 gallons per day of unpolluted mountain water and will be capable of future enlargement to yield twice this amount. This great undertaking, only just completed, had its inception as early as 1900. After exhaustive investigation actual construction was undertaken in 1906. While this addition to the New York water supply was under way, the city in 1911 faced a serious drouth and threatened water famine. This incident illustrates the necessity for foresight and wise planning if the water-works of our great cities are to be kept in point of development where they can safely meet the rapidly increasing demand for water, having due regard to natural causes affecting the quantity of the available supply from year to year.

Of no less interest is the recently completed Owens River supply developed by the city of Los Angeles. Rather than limit the future of the city by attempting further development of scant local water supply resources, Los Angeles, with great foresight, adopted the bold expedient of diverting an unused mountain stream 250 miles distant and turning it from its course into the desert to the uses of the city. At a cost of $24,500,000 it made available indefinitely a municipal supply of 259,000,000 gallons per day in a locality where water is more scarce and more valuable than in any other thickly settled part of this country. In doing this Los Angeles acquired a natural resource of almost inestimable value and has insured its future growth and supremacy in the southwest.

The city of San Francisco has undertaken a similar great municipal water supply project. It is now building works to develop by storage in the Hetch-Hetchy valley, 175 miles distant, a supply of 240,000,000 gallons per day, present maximum capacity. This supply is estimated to cost about $37,000,000 and may ultimately be developed to furnish 400,000,000 gallons per day. The works will include a great dam on the Tuolumne River and an aqueduct and equalizing reservoirs similar to those of the Catskill and Owens River supplies.

The immense difficulties overcome and the great engineering works carried out in recent years to develop adequate water supplies for some of our great cities have had their counterpart on a smaller scale in the planning and execution of works required for the supply of many of our smaller cities. These cities, even though oftentime

unfavorably situated for the development of the necessary quantities of water, must on account of more limited means depend on local sources of supply.

Ground water supplies have been very extensively developed during recent years, mainly by the smaller inland cities. Sometimes there has been practically no alternative source, but in other cases this source has been developed to supplement other supplies, or used in preference to a polluted river supply requiring filtration. In the case of the Bay cities of California, ground water supplies have been extensively developed to supplement a scant impounded supply in a region where no rivers for water supply are available, except at a great distance and prohibitive cost. The La Crosse, Wis., supply is a good example of the latest practice in developing ground water supplies from favorable water-bearing sands by means of driven wells. This city recently abandoned a polluted river supply for one that does not need artificial filtration. A modern example of one of the largest ground water supply developments is Des Moines, Iowa, which is able to develop an ample supply by means of infiltration galleries in the sand and gravel deposits of a nearby river.

Deep well supplies in some localities have continued to offer the best available supply in the case of a number of our smaller cities and towns, but the continued and increasing draught on these sources, with attendant lowering of the static water level, has made this supply in many cases less economical of development than when first tapped, and it is now well recognized that this source of supply is not always well adapted to progressive enlargement to meet the growing needs of the town supplied. The deep well supply will continue, however, to be a valuable asset to many of our smaller cities situated in certain well-recognized zones favorable to the development of water from the underlying rock strata.

With the continued growth of our cities and the increasing rate of water consumption, the problem of supplying water will continue to be a vital one for many of our cities, most of which are pressed to keep ahead of the insistent demand for more water. In certain sections of the country the very limited water resources are, without a doubt, a serious handicap to cities already existing. Where the growth of the city is sufficiently sustained, we may expect to see other great water supply projects undertaken, as at New York and Los Angeles, in order to overcome deficiencies or exhaustion of the local water supply resources.

SANITARY QUALITY OF WATER

The most notable recent advance in the art of water supply has been the improvement in methods of water purification. In the face of ever-increasing pollution of our water courses, the quality of water as supplied to the consumer has practically within the last fifteen years been raised to a high standard of purity and safety in most, if not all, of our public water supplies. This result has been secured in part by protecting watersheds from contamination, but is due mainly to the very general introduction of water filtration and water sterilization. Today it is the exceptional water supply that does not provide a safe, clear and practically colorless water. This is the greatest achievement of recent water-works progress.

The importance of the radical improvement brought about in the sanitary quality of our water supplies within the past twenty years, is indicated by the reduction in the typhoid fever death rate. George A. Johnson is authority for the statement that a reduction of 16 deaths per 100,000 population in the 33 cities having over 100,000 population in 1910, that have introduced some form of water purification, may be attributed to water purification. On this basis, in these cities alone, there are annually 2600 fewer typhoid fever deaths than under the old conditions with polluted water, and the saving in typhoid fever cases is estimated at 39,000 per year for these same cities. These conclusions are based on typhoid statistics for the period 1900–1912 by comparing the average rate for 1900 to 1908 with the average for period 1909 to 1912. If we take account of the increase in population using filtered water since 1912 and the population supplied with filtered water in communities of less than 100,000 people, it is evident that the above estimate of 2600 typhoid deaths per year is probably much below the actual total annual saving in this disease alone made by water purification. There is good evidence to show that the death rate from other causes has also been materially reduced by water filtration.

WATER FILTRATION

Stimulated by wide dissemination of modern ideas of sanitation, water filtration in the United States has made great progress during the past decade. The population supplied by filtered water, as

shown by Table 1, has increased from 3,160,000 in 1904 to 17,291,000 in 1914. As late as 1903 only about 60 cities and towns were supplied with filtered water, while there are now some 480 filter plants in this country with a total capacity of 2,585,000,000 gallons per day. These filters serve 40.86 per cent of the urban population, while in 1904 only 9.66 per cent of the urban population (including all towns of over 2500 population) was so supplied.

The relative growth of slow sand and rapid sand filtration during this period is interesting. It reflects strongly the relative adapability to conditions in this country of the two types of filters and the gradual acceptance by the general public of ideas in water purification looked upon with prejudice less than ten years ago. Although slow sand filters were the first to be introduced, by 1904 rapid sand filters, including the earlier "mechanical" filters, were far in the lead with a total population served of 2,600,000, as against only 560,000 supplied by slow sand filters. From 1904 to 1908 several very large slow sand filter plants were completed, at Philadelphia, Pa., Washington, D. C., and at Pittsburgh, Pa., and the relative lead of rapid sand filters was much reduced, although even then the population served by rapid sand filters was very nearly twice that supplied by slow sand filters. Since 1910 the growth of slow sand filters has been less marked. In 1914, a population of 5,398,000 received water from about thirty slow sand filters, while

TABLE 1

Growth in population supplied with filtered water in the United States by slow sand and by rapid sand filters

YEAR	TOTAL URBAN POPULATION IN THE UNITED STATES (TOWNS AND CITIES ABOVE 2500)	POPULATION SUPPLIED WITH FILTERED WATER			PER CENT OF URBAN POPULATION SUPPLIED		
		Slow sand filters	Rapid sand filters	Total	Slow sand filters	Rapid sand filters	Total
1870		None	None	0	0.00	0.00	0.00
1880	13,300,000	30,000	None	30,000	0.23	0.00	0.23
1890	21,400,000	35,000	275,000	310,000	0.16	1.29	1.45
1900	29,500,000	360,000	1,500,000	1,860,000	1.22	5.09	6.31
1904	32,700,000	560,000	2,600,000	3,160,000	1.71	7.95	9.66
1910	38,350,000	3,883,000	6,922,000	10,805,000	10.13	18.05	28.18
1914*	42,500,000	5,398,000	11,893,000	17,291,000	12.70	27.98	40.68

* Compiled January, 1914, by George A. Johnson.

upwards of 450 rapid sand filters supplied a total population of 11,893,000.

Although there are now in this country 15 rapid sand filter plants to one slow sand plant, the capacity of the larger slow sand filter plants is greater than that of any rapid sand filters yet built. The largest slow sand filter, located at Philadelphia and in service since 1908, has a rated capacity of 240,000,000 gallons per day. In contrast to this, the rapid sand filter at Cincinnati, completed in 1907, with a capacity of but 112,000,000 gallons per day, is the largest plant of this type in operation up to 1915. Present tendencies in

TABLE 2

*Decline in typhoid fever death rate in eight cities following the use of hypochlorite disinfection of the water supply**

CITY	BEGAN USING HYPOCHLORITE	BEFORE USING HYPOCHLORITE		AFTER USING HYPOCHLORITE		REDUCTION IN DEATH RATE
		Period	Death rate per 100,000	Period	Death rate per 100,000	
						per cent
Baltimore	June, 1911	1900–10	35.2	1912–13	22.8	35.0
Cleveland	September, 1911	1900–10	35.5	1912–13	10.0	72.0
Des Moines	December, 1910	1905–10	22.7	1911–13	13.4	41.0
Erie	March, 1911	1900–10	38.7	1912–13	13.5	65.0
Evanston	December, 1911	1907–10	26.0	1912–13	14.5	44.0
Jersey City	September, 1911	1900–07	18.7	1909–13	9.3	50.0
Kansas City	January, 1911	1900–10	42.5	1911–13	20.0	53.0
Omaha	May, 1910	1900–09	22.5	1911–13	11.8	47.0
Pouhkeepsie	1908	1900–08	54.0	1908–13	18.5	65.8

* Taken in part from paper by C. A. Jennings, "Hypochlorite Treatment Now Firmly Established."

this country are indicated by the fact that several cities are now building mechanical filter plants larger than any now in operation, while no large slow sand filter plants are under construction or projected. A rapid sand filter of 320,000,000 gallons capacity, 30 per cent larger than any existing slow sand plant, has been designed for the Croton water supply of New York. St. Louis has recently completed a rapid sand filter of 160,000,000 gallons capacity; at Cleveland two rapid sand filters are proposed with a combined capacity of 225,000,000 gallons, one of which is now about ready for service, the larger plant of the two having 150,000,000 gallons

capacity; Baltimore has a new rapid sand filter of 128,000,000 gallons capacity.

The rapid sand filter has outstripped the slow sand filter principally because it is better adapted to handle waters of the high turbidity characteristic at times of practically all our rivers outside of the extreme northeasterly portion of the United States. In many parts of the country, the slow sand filter, unaided by auxiliary processes, more especially coagulation and preliminary sedimentation, would be incapable of continuously handling the water except at greatly reduced rates of filtration, owing to the rapid clogging of the beds and great difficulty and time required in cleaning. The rapid sand filter, using coagulation and ample preliminary sedimentation that relieves the filters proper of a very large share of the burden of purification, and with easy means of cleaning the filter beds, has, on the other hand, repeatedly demonstrated its ability to properly and economically filter the most turbid waters. The growing recognition by engineers of the merits of the rapid sand filter is evidenced by the final recommendation in a number of instances of rapid sand filters, reversing earlier recommendation of slow sand filters, as in the case of New York, Baltimore, and Minneapolis.

Although the limitations of slow sand filtration in handling waters of high turbidity were early realized, these filters were often favored in preference to rapid sand filters. Popular objection to rapid sand filtration arose on account of its use of a coagulant. This prejudice is well illustrated in the case of Washington, D. C., where popular agitation resulted in the building in 1905 of a slow sand filter after the original recommendation of a rapid sand filter. Prejudice against the use of alum, and, in fact, against the use of other chemicals, either for coagulating, softening, or sterilizing water, has now been for the most part overcome. This is mainly due to the extensive use of coagulation at a large number of rapid sand filter plants, occasionally in conjunction with water softening, without ill effects on the consumer, and to the well earned public favor enjoyed by the process of water sterilization by means of hypochlorite of calcium.

While the rapid sand filter has overcome the prejudice under which it labored ten or fifteen years ago, and has been demonstrated as equal, if not superior in bacterial efficiency to the best slow sand filters, it is of interest to note that the attempt in recent years to apply slow sand filtration outside of its proper zone of relatively

clear natural waters has not met with success. This attempt has brought about very radical departures from early slow sand filtration practice, and has obscured the original sharp distinction between this type and the rapid sand filter, without evolving a superior filter. It has been necessary to resort to coagulation at the Washington slow sand plant, in spite of very long preliminary sedimentation. At Philadelphia and at Albany, preliminary filters which are practically rapid sand filters, have been added to better enable the slow sand filters to do the work originally expected of them. At Pittsburgh extensive modifications have been necessary to properly prepare the water for the slow sand filters that had been proved incapable alone of producing a satisfactory effluent. The reliance now placed on sterilization of the filtered water at most of the principal slow sand filter plants shows further the wide departure made from the original slow sand process, in the effort to keep the performance of some of these plants up to the standard originally intended of them without the help of these and other auxiliary processes. All of these processes are foreign to the original idea of a "natural" process for water purification, which gave to the slow sand filter much of its vogue and played an important part in meeting the early competition with the so-called "mechanical" filter and the present rapid sand filter.

The process of rapid sand filtration was highly standardized ten years ago, and has undergone little change in the last few years beyond the incorporation of water sterilization as an additional safeguard, and a more general appreciation of the importance of preliminary sedimentation. Filters of this type follow closely the lines of the original modern rapid sand filter built in 1902, at Little Falls, N. J.

Although it is well understood that any filter has a definite limit of capacity beyond which it is not possible to obtain properly purified water, there is a tendency to operate filters at greater than the safe rates, as the plants are outgrown. The danger in this practice is evident, and engineers generally are disposed to discourage it, and, so far as possible, to anticipate it by designing with ample provision for the needs of the immediate future, and with special attention to facility for making future additions.

There is a further tendency of late to overconfidence in filtration as a preventive of disease, and a disposition in some quarters to attempt the filtration of badly polluted waters in preference to more

expensive and distant sources. The engineer and the sanitation expert of today is engaged in pointing out that it is not a proper or wise policy to overload water filters from a poor source of supply.

The field of possible application of water filtration, and more particularly rapid sand filtration, is today a very broad one. Practically all river and large lake municipal water supplies, and many impounded supplies, must eventually be filtered to meet the rapidly spreading demand for uniformly safe and potable water. We may reasonably look forward to an extension of water filtration during the next decade fully as great as the growth from 1904 to 1914.

WATER DISINFECTION

The calcium hypochlorite process of water sterilization is the most important single contribution to the art of water purification in recent years. This process, introduced in 1908 at the Boonton reservoir of the Jersey City Water Supply Company, spread very rapidly to the great benefit of our public supplies. Many cities which were not ready to undertake water filtration applied the bleaching powder process of sterilizing the water as an emergency measure. Many water-borne typhoid epidemics were controlled by this means and some very remarkable results were secured in the reduction of the typhoid death rate.

A radical improvement in water sterilization methods was made with the introduction in 1910 of liquid chlorine, and this process has practically supplanted the older one and, through overcoming some of the objections to the hypochlorite process, has further extended the field of water sterilization and has been of great value in improving the sanitary quality of many public water supplies.

Although water sterilization deserves every praise, continued experience leads to the conclusion that this process should not displace filtration in waters containing more or less suspended matter. It cannot make a dirty water clean or wholesome. While it has been very successful as an emergency measure, even on waters to which it is not best adapted for continual use, it should not be regarded as a proper permanent remedy for a badly polluted supply or one in which the water is periodically of high turbidity. The tendency of the best water-works practice is to adopt filtration with sterilization as an added safeguard in such cases.

The very remarkable development of hypochlorite disinfection in

this country and the more recent introduction of liquid chlorine have put water purification on a sound basis. We are safe in concluding that disinfection has come to stay, even though the disinfecting agent may be changed in the future by the further improvement of processes now known or the discovery of new and better methods.

The ozone and violet ray processes of water sterilization have been exploited to a very limited extent in this country. They have not as yet found application on a commercial scale in any of our important public water supplies, and it does not appear likely that they will soon displace the liquid chlorine process, if at all.

EVOLUTION OF PUMPING MACHINERY

The apparently secure place occupied a few years ago by the cross-compound, high-duty reciprocating pump is today challenged by the turbo-centrifugal pump.

Until very recently the vertical, triple-expansion, reciprocating pumping engine was preeminent for high service pumping under continuous operation where capacities ranging from 10,000,000 to 30,000,000 gallons per day were required. This type of engine was highly developed over a decade ago and has undergone comparatively little further improvement in the last ten years. It seems that the limit of its performance has practically been reached at 185,000,000 foot pounds per 1000 pounds of dry saturated steam. The use of superheated steam has raised the attainable duty limit to slightly above 200,000,000 foot pounds per 1000 pounds steam, although the duties are not comparable on this basis. The introduction of superheated steam has not become general, even in the larger plants, though it represents the principal recent advance made in improving the performance of this type of pump.

Also, until recently, for the smaller capacities required in high service units ranging from 2,000,000 to 10,000,000 gallons per day, the horizontal, cross-compound, crank-and-flywheel condensing pumping engine has had a practically undisputed field in water-works service. These machines have a duty range of from 110,000,000 to 145,000,000 foot-pounds per 1000 pounds dry steam and have very generally superseded the direct-acting, non-rotative pumping engines formerly used. This type, like the triple-expansion pumping engine, was so far perfected ten years or more ago that but

TABLE 3

Duty performances of vertical triple expansion pumping engines

BUILDER OR DESIGNER	DATE OF TEST	LOCATION OF ENGINE	CAPACITY PER 24 HOURS	PISTON SPEED	HEAD		STEAM PRESSURE	INDICATED HORSE POWER	MECHANICAL EFFICIENCY	STEAM I. H. P. HOUR	B. T. U. I. H. P. MINUTE	DUTY IN FOOT POUNDS PER 1,000,000 B. T. U.	DUTY IN FOOT POUNDS PER 1,000 POUNDS STEAM	THERMAL EFFICIENCY
			gallons	*feet*	*feet*	*pounds*	*pounds*		*per cent*					*per cent*
1. Edw. P. Allis Co.	1900	St. Louis, Mo., No. 10.	15,000,000	197.00	292.00	126.0	126.00	802.00	96.8	10.680	202.0	158,077,320	179,454,250	21.00
2. Edw. P. Allis Co.	1900	Boston, Mass. (Chestnut Hill)	30,000,000	195.00	140.00	61.0	185.00	748.00	93.3	10.330	196.0	163,925,300	178,497,000	21.63
3. Edw. P. Allis Co.	1903	St. Louis, Mo., No. 12	15,000,000	197.00	293.00	126.8	135.00	796.00	97.7	10.880	205.2	156,900,000	177,200,000	20.67
4. Allis-Chalmers	1906	Milford, N. J.	12,000,000	203.60	334.75	145.2	176.67						181,433,826	
5. Holly	1909	Albany, N. Y.	12,000,000	221.40	322.21	139.8	153.56						182,281,000	
6. Allis-Chalmers	1909	Nashville, Tenn.	20,000,000	239.04	385.00	167.0							184,700,000	
7. Allis-Chalmers	1910	Milwaukee, Wis.	12,000,000	204.20	279.00	121.0		618.00	97.1	10.820	209.0	151,000,000	175,400,000	20.25
8. Holly	1910	Philadelphia, Pa.	20,000,000	221.43	220.85	95.9	180.19					163,330,000	184,476,000	
9. Camden Iron Works	1908	Cincinnati, Ohio	30,000,000	248.00	140.00	61.0	151.40	811.00	93.1	10.720		154,600,000	171,700,000	19.86
10. Camden Iron Works	1908	Cincinnati, Ohio	30,000,000	248.00	140.00	61.0	148.90	806.30	93.90	9.550		163,000,000	194,403,500*	21.99
11. Bethlehem Steel Co.	1914	Pittsburgh, Pa. (Mission St. Sta.)	7,000,000	200.69	441.08	191.5	160.40	574.83	97.63	9.597			201,662,445†	

* 163° superheat.

† 100° superheat.

slight improvement has since been made in its efficiency. Both the vertical compound and the horizontal direct-acting, non-rotative, triple-expansion pumping engines are still in the field, but less generally used in water-works service than the cross-compound pumping engine and the vertical triple.

Great strides have been made in the last two or three years in improving the efficiency of the turbo-centrifugal pump, which until recently was useful in water-works service mainly for low lifts or as reserve machinery for peak load and fire service. The efficiencies now attainable with this type of machinery greatly extend its field of usefulness in water-works practice and promise to make the various types of reciprocating pumps obsolete in the near future. Centrifugal units are now being built with duty guarantees equal to those of high-duty, cross-compound pumping engines operating under the same conditions. On the basis of equal duties the advantage of first cost and compactness is in favor of the centrifugal pump.

Although the record duty so far obtained with centrifugal pumps in water-works service, 164,000,000 foot-pounds per 1000 pounds dry steam, is still considerably below the best vertical triple-expansion pumping engine duty records, the smaller first cost of the turbo-centrifugal unit gives it the advantage over the older type of machinery. There is little question but that the present tendency is toward a very considerable invasion of the water-works pumping field by the latest types of high-duty centrifugal pumps.

Gas-driven pumps have had only rather limited application to municipal water-works service in this country, and there does not appear to be any marked tendency to increase the use of this type of machinery on a large scale.

Interesting developments have been made since 1900 in means for the withdrawal of water from tubular wells, not only for ground water but for deep well supplies. Following the first notable installation of tubular well centrifugals at Petrograd, Russia, in 1900, self-balancing centrifugals of small diameter in multiple were successfully made and tested at the Clearing Yards in Chicago in 1902, with efficiencies of about 50 per cent. Installations at La Grange, Ill., Waterloo, Iowa, and Milwaukee followed, and this type of pump, while not having a wide field to fill, has proved itself useful where needed. A recent installation at Rockford, Ill., includes not only tubular deep-well centrifugals in multiple, but is augmented

by series centrifugals at the surface of the ground, delivering the well water under city pressure directly into the city distribution system. Notable experience with tubular well centrifugals has been had in a number of suburbs of Chicago, at Memphis, Tenn., Winnipeg, Canada, and elsewhere.

THE DISTRIBUTION SYSTEM

In keeping pace with our rapidly expanding cities, water works distribution systems have been in the aggregate greatly extended during the past decade. Largely as a result of the influence of this Association, standardization of cast-iron water pipes has been brought about. Valuable experience has been gained in the comparative advantages of various materials for water pipe under widely varying conditions. The problem of electrolysis has received much attention, and has led to the application of corrective measures. The important part played by the distribution system in continuity of service has been demonstrated in several noteworthy and regrettable instances. Breakages of mains from defective pipe, by water hammer, by settlement and displacement of pipes from nearby construction, and by flood, fire and earthquake, have all been the cause of serious interruption of service and in some cases disaster.

The losses, sustained as a result of these breaks, through interference with industry, suspension of fire protection, and pollution of the water supply, have been in some instances very great. Some of the worst conflagrations of the past decade followed water pipe breaks that resulted in failure of fire protection at a critical time. The importance of avoiding such losses and increasing the factor of safety in water distribution has led, in some cases, to the provision of cisterns scattered through the distribution system where there is danger of disruption of the system from any cause. The need of having duplicate supply mains or conduits and the importance of provision for promptly isolating parts of the distribution system, by valves always accessible and quickly found, and other precautions, is perhaps much better recognized today than formerly.

No notable changes in the material of distribution pipe and accessories has taken place of recent years. But much more attention is being given to clean interior surfaces, and means for this kind of maintenance are better known and utilized. Of special interest has been the ingenious development of making large con-

nections and inserting valves, without shutting off the flow of water. Cast-iron pipe of 16-foot-lengths are now manufactured and are available, and the joint for cast-iron pipe has received much attention, without so far seriously displacing the standard practice of using lead.

WATER CONSUMPTION

With several of our largest cities still lavish in the waste of water, it is plain much remains to be done in bringing about economy in the use of water and the elimination of waste. The per capita consumption of water in this country varies from less than 40 gallons per day in some cities to 400 gallons per day in others. This wide range in rate of consumption is still more striking if we compare it with the prevailing rates in Great Britain, where the combined domestic and trade consumption is in several cities even below 25 gallons and the highest rate reported only 70 gallons per capita. Even allowing for a somewhat more liberal legitimate domestic use of water in this country, it is difficult to reconcile the high rates so common in this country with the low per capita consumption abroad, and the lower rates of consumption in some of our own cities. The explanation is to be found mainly in leakage and lavish and careless use and waste on the part of the consumer. This has been demonstrated repeatedly in recent years by thorough investigations, by successful campaigns to reduce waste, by water waste surveys and by wide experience with metering.

New York City, threatened by water famine before the completion of the Catskill supply, was able in 1912 by systematic surveys and a waste prevention campaign to reduce the total water consumption 90,000,000 gallons per day below the estimated needs for that year. Washington, D. C., and other cities have carried on work of this kind on a more or less extensive scale and with beneficial results. Waste surveys in Chicago not long ago revealed an astonishing amount of leakage and led to the detection of entirely unsuspected sources of waste.

Ingenious devices have been developed for measuring and checking the flow of water in distribution mains.

METERING

Unintelligent opposition still stands in the way of metering in such important cities as Chicago and Buffalo and in many smaller

cities, where the present apparent per capita water consumption is altogether unreasonable. The presence of an abundant visible source of supply, as at Chicago, without doubt militates against considerations of economy and strengthens the popular notion that water should be "free as air."

These cities may be expected in the not distant future to fall into line by adopting an effective policy of metering. The possibilities of economy of water in these cities, now using in some cases as high as 400 gallons per capita per day, are best indicated by the prevailing low rates of consumption in those cities that have adopted

TABLE 4

*Comparison of percentage of metered services at different periods in eighty-two large American cities**

PRESENT SERVICES METERED	1900		1906-12†	
	Number of cities	Total population	Number of cities	Total population
per cent				
100	1	32,700	7	660,300
75–100	13	848,700	21	2,818,900
50– 75	5	509,300	12	1,004,000
25– 50	15	1,221,200	14	1,718,600
10– 25	9	636,300	10	2,047,100
0– 10	39	11,513,500‡	18	11,569,300§
Total and averages.....	82	14,761,700	82	19,872,200

* These cities were all over 25,000 population in 1900.

† The data in this column were obtained for various years from 1906 to 1912, inclusive, most of them being for the years 1910, 1911 or 1912.

‡ Includes New York and one other city reported as having no meters.

§ Includes New York and six other cities reported as having no meters.

metering, including Cleveland, Milwaukee, Hartford, Des Moines and many others. The striking results in economy where metering has been applied to a wasteful system is sufficient argument for the general adoption of this policy wherever apparent consumption of water is beyond all reasonable use. The few examples, of which York, Pa., is a striking instance, of moderate water consumption although practically unmetered, are exceptions rather than an argument for unmetered services.

The great loss of continued and unnecessary increased water supply development, especially under present abnormal prices,

makes it doubly important for all of our cities to keep water consumption within bounds. Threatened outgrowth of supplies already developed and the growing need for the greatest possible economy in plant operation may be expected to greatly accelerate the adoption of metering in those cities that have not yet taken advantage of the meter system, which offers at once the only fair method of selling water and the best insurance of economy in use of water.

VALUATION AND RATES

During the decade just passed, there has been a notable movement for state and national regulation of public utilities where water supplies have been privately owned, and in some states, where they are municipally owned. This regulation has operated to control more thorough examination of the value of the property devoted to the public use, the proper return to be afforded it, and the just and equitable apportionment of the income to be raised among the different classes of consumers. Nearly all of the states now have established public utility commissions having more or less power to regulate rates, require uniform accounting, and value property devoted to the public use. A very few of these commissions, with restricted powers, existed prior to 1907, but the great majority of them, and notably their enlarged powers, have been created since about that date. Inasmuch as these commissions are largely new to their responsibilities and the subject of rate regulation, both in the economic, financial, and legal questions raised, is admittedly difficult and complicated, their proceedings are watched with interest, and the subject is now being extensively studied.

During the past decade the transfer of water supply utilities to municipal ownership has continued, though less rapidly than in prior years as the number of privately owned plants diminishes. Approximately $15,000,000 in value of private utility property in water supply has become municipally owned since 1905 in the United States, and several large properties yet remaining in private hands will undoubtedly be transferred to the public control at an early day.

CONCLUSION

Any attempt to cover the notable matters in which municipal water supply has progressed in this country during the last decade

must necessarily be treated broadly. Many interesting developments of a minor character must necessarily be omitted, but it is believed that the more important developments have been described.

For the future it is apparent that more attention is to be given to the conservation of our available supplies and their protection from contamination. This movement is already well begun in the studies of the Great Lakes, the sanitary survey of the Ohio River, and the valuable and earnest work of the state water surveys now in progress in many states over the country. More and more will this close watchfulness over the purity of our water-courses and water reserve prevail, if present indications are any guide.

Another tendency in the near future will undoubtedly relate to the increased curtailment of waste. This movement, already well in progress, will have yet wider attention the more its economic necessity becomes apparent and the increasing difficulty of extending present supplies compels the attention of our municipalities.

New and revolutionary discoveries are always possible in any art, but without discussing these opportunities for betterment it is easily to be seen that we have yet a great deal to do to organize, systematize, and standardize the problem of public water supply in this country in the next few years.

DISCUSSION

RUDOLPH HERING: The author has prepared the best short compilation of known facts on this subject that the speaker has seen anywhere. He has not only touched upon all of the chief elements that must be considered in water supplies, but he has brought out the present views of those who have been engaged in water supply development. He said that the consumption in Europe is very much less than here, because the people there are in general more economical. The traveler in Europe is constantly surprised to see how saving they are with water. The speaker had the pleasure of visiting several American cities with J. D. Watson, one of the leading English engineers, and observed that he could not suppress his continual astonishment at what he termed the inexcusable waste of water in American hotels and homes. The waste is really a question of habit and custom and unless Americans radically change their custom we will have to provide for a constantly increasing consumption.

There is perhaps one thing that might be added to the points raised in the paper. It has not been regarded in the United States as much as in Europe as an important matter, where it has been held so important that it has in several cases decided the selection of the source of water supply. This is water temperature. Berlin, Vienna, Hamburg, Paris, and most large European cities are largely, if not wholly, supplied with ground water. Their people say, "We wish low temperature, we wish to have the water delivered in our houses like spring water, clear and cold." Therefore, ground waters have been developed because it is practicable to preserve their low temperatures. It is quite practicable and safe to introduce them also in the United States more than has been done, particularly along the Pacific Coast and in the northern sections. There is a great future for that class of supply in this country. Most ground waters do not need filteration and when kept in covered reservoirs are cooler. In Europe the consumption of ice in summer is very low as compared with that here, mainly due to the fact that they have cool water when drawn from the spigot in almost every city.

FRANCIS F. LONGLEY: The speaker was interested in the remarks on the author and likewise of Dr. Hering as to the smaller waste in European cities as compared with that here. The statement is frequently made in this country that in order to meet American conditions it is impossible to have a distribution system that will account for 100 per cent of the supply furnished to the city. The office with which the speaker is associated recently had occasion to study this question at some length, and in the course of the study to refer to European statistics bearing on waste in water consumption. The statistics referred to covered some four hundred cities, mainly in Germany. Out of these 400 cities there were reported for the year 1912, 11 cities in which 100 per cent of the water furnished was accounted for, 36 in which at least 95 per cent was accounted for, and nearly half of the entire list accounted for 75 per cent or more of the supply. The best records of American cities do not approach these figures. The speaker does not know of any record as high as 95 per cent. Records of 85 per cent are infrequent and the percentage of cities accounting for 75 per cent or more is certainly not large.

In these European cities, of course, water mains and fixtures are not provided on the same generous basis as here in the United

States. Here there is a tendency to provide facilities for the use of water whenever it will be even remotely convenient. There the tendency is to provide fixtures only where necessary. The number of fixtures per unit population is much smaller than here. The per capita consumption there is nearly everywhere lower. The use of meters on every service is much more general. A more definite control is exercised over waste of water. These factors all contribute to a smaller amount of waste or a larger percentage of the total supply accounted for. Nevertheless, this comparison has an important significance, and most American cities may well take a lesson in thrift in this phase of the water supply problem from these European cities.

JAMES W. ARMSTRONG: The author has called attention to the increasing use of centrifugal pumps for water works purposes, and compared the efficiency and first cost of high duty, reciprocating pumping engines, with centrifugal pumps, but he said nothing regarding the comparative cost of the operating force necessary to run them. Very little attention seems to have been given to this item of expense, yet it is one of the most important entering into the consideration of a given problem. While local conditions have much to do with the number of men employed in any plant, and comparisons of isolated cases are liable to be misleading, there should still be a value in all reliable figures comparing the labor costs of the two types of plants.

The writer has access to the labor costs of operating three different pumping stations in the city of Baltimore, and submits a comparison hoping that additional information of a similar kind may be published.

By comparison it will be seen that the Mt. Royal Pumping Station has an annual cost per million gallons of capacity 7.3 times greater that that of the Montebello plant. The cost of the boiler room labor has not been taken into consideration, as the Montebello plant is electrically driven and no such cost exists.

The larger a centrifugal pumping plant is, the smaller will be its annual cost per million gallons of capacity. For instance, the Montebello plant could have its capacity increased to 240,000,000 gallons without requiring any additional force for operating, and its annual cost per million gallons would be then reduced to $18.12.

On the other hand, the writer knows a small water works centri-

The Mount Royal pumping station—water

Total pumping capacity, 65,000,000 gallons per day; head pumped against 242 feet. Installation, one 30,000,000-gallon vertical triple-expansion engine (new), 180,000,000-foot pounds duty; two 17,500,000-gallon horizontal, duplex, triple-expansion engines (old), about 115,000,000 foot-pounds duty.

NUMBER OF MEN	POSITION	ANNUAL SALARY	ENGINE ROOM COST	BOILER ROOM COST
1	Engineer in charge	$1,300	$ 1,300	
2	Watch engineers	1,200	2,400	
1	Assistant engineer	1,080	1,080	
1	Auxiliary engineer	10,20	1,020	
3	Oilers	720	2,160	
3	Firemen	780		$2,340
1	Mechanic at $3.50 per day; average 300 days; half time to engine room		525	525
19	Laborers at $2.25 per day; average 300 days; 35 per cent engine room and 65 per cent boiler room		4,489	8,336
			$12,974	$11,201

Annual cost of engine room, per million gallons capacity, $199.60.

Main sewage pumping station

Total pumping capacity, 72,500,000 gallons per day; head pumped against, 72 feet. Installation, three 27,500,000-gallon, vertical triple expansion pumping engines, 165,000,000 foot-pounds duty.

NUMBER OF MEN	POSITION	ANNUAL SALARY	PUMP ROOM COST	ENGINE ROOM COST
1	Engineer in charge	$1,500	$1,500	
4	Shift engineers	1,140	4,560	
3	Assistant engineers	1,020	3,060	
3	Oilers	720	2,160	
4	Firemen	780		$3,120
1	Mechanic	1,020	510	510
1	Helper	960	480	480
1	Storekeeper	1,020	510	510
8	Laborers at $2.25 per day; average, 300 days; half time to engine room	5,400	2,700	2,700
			$15,480	$7,320

Annual cost of engine room per million gallons of capacity, $213.51.

Main pumping station, Montebello filters

Total capacity, 160,000,000 gallons per day; head pumped against, 39 feet. Installation, four electrically-driven centrifugal pumps, one of 30,000,000 gallons, two of 40,000,000 gallons and one of 50,000,000 gallons capacity.

NUMBER OF MEN	POSITION	ANNUAL SALARY	PUMP ROOM CHARGE
3	Operating engineers	$1,200	$3,600
1	Mechanic for relief duty and repairs, half time	1,500	750
			$4,250

Annual cost of pump room per million gallons of capacity, $27.19.

fugal plant located in an isolated position where men are kept on duty more for possible emergencies than for actual operating requirements, where the annual labor cost per million gallons of plant capacity is over $400. Contrasted with this, and in another city, is a group of small sewage pumping stations, operated automatically by float switches. These stations have been run satisfactorily for a number of years without any regular operator. The only attention they receive is a daily examination from an inspector. The widely different labor costs as shown by the above examples would indicate the desirability of looking carefully into such cost when studying the possibilities of a new installation.

RELATIONS BETWEEN WATER DEPARTMENTS, COMPANIES AND THE PUBLIC[1]

By W. C. Hawley

The good-will of its consumers is the best asset which any water company or water department can have. How can we get that good-will and how can we keep it? We must get it into our minds clearly that we are engaged in public service. Neither the water department nor the private water company has any business to dabble in politics. That iridescent dream of municipal ownership will never materialize while politics continue to govern municipally owned utilities, and the privately owned utility which monkeys with politics is committing corporate suicide.

To secure the good will of our consumers, we must have good service, and is discussing the topic it will be assumed that good service is being rendered. After good service, one of the most necessary requisites is a good and reasonable set of rules, intelligently, impartially and courteously enforced. Many of the rules now in force need to be revised, brought up to date, and their unreasonably arbitrary features eliminated. They should be made as brief as possible and yet stated plainly, in language that can be easily understood.

The rate schedule should be such that there can be no reasonable charge of discrimination. Most of the rate schedules today are years behind the times, either mere copies of older schedules or else they are schedules compiled by men who knew nothing of rate making. Few of them are based upon any intelligent study of the costs of service and they cannot be explained satisfactorily or justified.

Assuming that we have satisfactory service, rules and rates, our next problem is to secure employees who can meet and transact business with the public with a minimum of friction and trouble. Our office force, especially, should be of more than average intelligence and education and able, at least, to use the English language

[1] Read before the Richmond convention, May 8, 1917.

correctly and to express themselves clearly. Our goods are not wrapped up and passed over the counter for cash, but instead we must deal with each customer on his own premises, and since we must serve all sorts and kinds of people, our business is a particularly difficult one. We must impress our employees with the idea that they are public servants and not public masters. Courtesy must be demanded in the treatment of all, and this applies not only to the office force but equally as well to the inspectors and meter readers who go to our customers' houses.

Our office employees should not only be very familiar with the rules, but they should understand the reasons for the rules. We should impress upon them the fact that we need no rules for the great majority of our customers, to whom we could and would be glad to extend courtesies, just as a merchant conducting his own business extends courtesies to many of his customers; but that since we must deal with all kinds of people there is a small minority for whom we must have rules, and since we can have but one set of rules those rules must apply to all. Everyone of us has experienced the difficulties which occur over the counter in the front office. The woman who got a bill for 50 cents excess over her minimum rate this last quarter, who never exceeded the minimum before and, therefore, there must be something wrong with the meter. The landlord whose tenant let the water run to keep the pipes from freezing and who has a large bill in consequence which he insists must be reduced. The crook who reversed his meter and got caught at it. The man who forgot to pay his bill during discount period and thinks that you are robbing him because you will not allow the discount. The man who forgot to pay his bill and let it go until the water was shut off. Or worst of all, the well dressed woman who prides herself upon her culture and social standing, who knows little or nothing about business, but has decided that that water bill will be reduced or she will give the people in that water office a piece of her mind. We can sympathize with the employee who has to deal with these people, but we must insist upon courtesy, self-control and an intelligent handling of all such cases. Let us bear in mind, however, that we cannot expect to obtain employees with the training and ability to handle such matters satisfactorily for the small salaries that are generally paid to those in such positions.

In most cases trouble and complaints result from misunderstandings. The clerk who handles such cases should have available all

of the necessary information, and unless he has this information he should not attempt to settle the matter until he has secured it. In the case of meter accounts, much time and friction can be avoided if the meter readers will make it a practice in the case of all unusual registrations to secure information while at the property, and make inspections to locate leaks and an inquiry as to whether or not there has been a leak, and when repairs were made and who made them. This information concisely entered in the meter book is worth all the time required to get it. In many cases the mere fact that there is such a record will save much trouble.

Frequently the argument is made that the meter will run all the time, or will register too much. The best answer to this which the author knows is a glass case meter. Such a meter installed in his office some months ago has proved most effective. An hour spent in arguing would not have convinced the customer, but two or three minutes spent in watching the meter operate, seeing that it stops when the water is shut off, that it will run on a very small stream, etc., has ended the argument in every case. Most customers who come into the office with trouble on their minds and are met with courteous explanations, go away with a friendly feeling, which it is well worth some trouble and expense to secure.

Few other things cause so much trouble to a water works man as mistakes in meter reading, billing and accounting. We cannot prevent our customers getting wrong ideas in their heads or finding fault about a large bill, but we can and should reduce to an absolute minimum, trouble caused by mistakes made in our own office. Such mistakes can be largely prevented by a system which provides in cases of unusual registration for checking the meter reading by a re-reading, an inspection for leaks past or present, and a thorough system of checking bills and consumers ledger entries before the bills are permitted to be sent out of the office. These things cost money, but they are worth all they cost, for they make for us satisfied customers, which, as was stated in the beginning, are the best assets we can have.

So much for those things which we can control and for which we are responsible. Now for the newspapers, and this portion of the paper is approached with fear and trembling, for the newspapers have the last say and if they do not like what we say they can give us—anything they like. No other outside influence can do more to promote friendly relations between those responsible for water

supply and the consumers than the newspapers, and no other influence can cause more trouble and friction if the publishers wish to make trouble. Assuming, as before, that the service can be rated good, still no water works service can be perfect. Leaks will occur, supply will be interrupted occasionally, streets have to be dug up, odors and tastes in the water will occur, and the newspaper has an opportunity to do great service to the community by a fair and reasonable presentation of the facts. But if there is personal malice, political animosity, or a tendency to yellow journalism, such matters can be misrepresented, distorted and magnified to an extent which will stir up a whole community, causing endless trouble and ill feeling and add seriously to the burdens of the water works man without accomplishing the slightest good to anyone. The fact that harm is done and no good accomplished has no weight with such a publisher. He must knock somebody and if the city administration is not of his brand of politics, if the water company will not advertise, or if his paper is read by people of socialistic tendencies and he thinks that it will boost the circulation, the editor proceeds to hammer the water department or water company and then writes letters to himself commending his paper for the stand which it has taken on behalf of the down-trodden public.

There is little that can be done in such a case. Once in a while a personal interview and a frank and friendly discussion of the point at issue will produce results, but generally there is such a combination of malice, prejudice and ignorance that an interview only gives opportunity for additional columns of mis-statements, surmises, insinuations and abuse. We know of no remedy for such cases. Fortunately, the majority of our newspapers mean to be fair and appreciate the service which they can render to the public at large by promoting good feeling between the people and those public utilities that are honestly trying to serve them. For the others, we can only trust that the common sense of our satisfied customers will discount and offset the influence of these newspaper pirates, and that some day, in spite of their lack of intelligence and conscience, they (the aforesaid pirates) may be forced to realize that such journalism (?) is at least poor business policy. No criticism can be made of the newspaper which voices complaint of poor service provided it is done intelligently. It can perform no greater service to the community. However, great harm can be done if a city's papers are constantly hammering the water supply; for

people who are considering the city as a place of residence will be likely to go elsewhere.

The average water works man may be pardoned if he is a little sore on modern journalism, or at least some of it. Who is there in responsible charge of a water works system, either public or private, who has not at times, in spite of honest effort to the best of his ability, suffered newspaper censure, criticism or even abuse? How many of us have operated the plants for which we are responsible through the period of a great fire when the plant has been taxed to its utmost to meet the unusual demands made upon it, and who, down in the bottom of his heart, knows that the plant has rendered the service for which it was called upon, that the plant which he planned met the emergency successfully for which it was designed, only to pick up the morning paper and read scare headlines of "Water Famine," "Failure of Water Supply," etc.? Who has not been the victim of bitter criticism because such and such a fire hydrant was out of order and the firemen could get no water at yesterday's fire, when as a matter of fact the only failure was that of an excited fireman to open the hydrant? Within the past twenty-five or thirty years, when the question of water meters has been presented for the first time in our large towns and cities, a large part of the American press has taken the wrong side of the argument and opposed the introduction of the meter system, and in spite of the universal experience with meters, the same thing is taking place in some of our cities today.

We have no quarrel with those newspapers which give us a square deal. Many of the editors and reporters are our personal friends. But we are considering those things which affect our relations with the public, and of these the newspaper is one of the most important. We ask no special favor of the press, but we do ask for fair treatment. We have no objection to criticism when criticism is due, but let it be based upon a thorough knowledge and understanding of the facts and constructive not destructive. When "Pro Bono Publico" or some other fellow in that class, writes a letter of complaint about his big bill or other trouble, we feel that the newspaper should get the other side of the story from the water office before publishing the letter. Every water works man knows that the majority of such complaints have no reasonable foundation. Few would be published if the facts were known and very few of the letter writers would want their letters published if the facts were published too.

No good is done by publishing unfounded complaints unless to afford a head line and fill some space, but the prejudice created against the water utility is unfortunate, both for the utility and for the community. Let us hope that the day is coming when all newspapers will consider these matters and realize the harm done by the publication of unwarranted attacks upon our utilities; that when the utilities are discussed in the press the statements shall be authentic, accurate and intelligently presented, and that the expression so often heard, "it is only a newspaper yarn," shall be supplanted by one more creditable to the press.

RELATIONS BETWEEN A WATER DEPARTMENT AND THE PUBLIC[1]

By A. A. Reimer

The relations between a water department and the public forming the customers of such department differ to some extent from the relations which may exist between a private company and its consumers. A private company seldom, if ever, performs the function of being in business for the sole benefit of the people supplied by it, the primary purpose for existing being that of gain. On the other hand a municipal department holds the same relation to its customers as that occupied by an association or company doing a life insurance business on a mutual basis, the profits being evenly distributed among all those forming the association, or, in the case of a water department, drawing water from a municipal plant. For this reason the attitude assumed by the authorities in charge of a municipal water department must of necessity differ in character or form from that assumed by those controlling a private company. While this latter statement controls in many respects, it must be borne in mind at all times that there are certain fundamental principles on which both private and municipal plants must agree as regards their relation to the public. These points of similarity will be touched on later.

A municipal plant, not having to strain every nerve to produce a large dividend for a small number of stockholders, but to give the best service possible with existing physical conditions, to every citizen alike, can devote its energies to providing a water supply absolutely above reproach as to quality and quantity and to educating its consumers into expecting nothing but the best, so that failure to render such quality of service will result in general censure of those in charge of such work. It should provide a distribution system capable of furnishing proper domestic supply at all times and, in addition, giving that large measure of fire protection which will preclude any possibility of conflagration under anything like

[1] Read at the Richmond convention, May 8, 1917.

normal conditions. The rates to be charged for the service rendered should be based on such principles as have been found to be economically fair and financially sound.

The ideal toward which a municipal department should constantly work should include the highest standards of service on the part of every officer and employee that it is possible to obtain, much criticism in the past having been hurled at municipal departments because it has been found that "soft jobs" were being found for persons absolutely unfitted and unqualified for the work they were presumed to conduct. Any operating department of a municipality, be it water, light, power or other utility, is open to this particular criticism and should be jealously guarded by the officers who are finally responsible to the public for the proper conduct of such departments. We can all point our fingers at municipal departments which are notoriously bad in this regard. But the author's experience in active business for nearly twenty years has been on both sides of the fence and when he was in private corporations he became convinced that there are just as many private corporations where "soft snaps" exist and where rottenness in management may be found as is the case with municipally owned utilities. He has not yet found it possible to change that opinion during recent years since he has been connected with municipal service. He is not condemning either form of ownership but prefers to look at the benefits to be found in each type, for there are benefits in the case of both.

A municipal water department, in the majority of states, has almost autocratic powers in conducting its affairs. It does not have to ask favors of the municipality in which it operates. It does not have to appease the wrath, many times unjustly roused, of some peace disturber in the form of a city alderman seeking for notoriety at the expense of a private utility. Its way is smoothed in many respects by laws making sure the receipt of all charges billed against the water users. But these very benefits and privileges impose on such a department the necessity for just treatment, high grade management and earnest endeavor. If any difference is to exist between a privately owned water purveying company and a municipal department that difference should be expressed in a higher grade of service in the municipal plant than is found in the private plant. We are paid for the service rendered a municipality, but the fact that it is a service of the public should bring with it

to every person so engaged the thought of patriotic stewardship and the determination to give more than 100 per cent service.

There are some items which may be mentioned in which differences between private and public plants disappear. Any concern in business for profit or public service faces the problem of the proper method of meeting the public singly or in groups. Much of the financial success of a business for profit depends on the wise solution of this particular problem and any department of a municipal government brings praise or censure on the governing administration according as its treatment of the public is satisfactory or not.

A highly important element of success in the relations under discussion is courtesy. No matter how thoroughly alive to business principles anyone may be, impolite demeanor in meeting customers must eventually drive all such away with a feeling of ill treatment and resentment, and it requires but a short time to pass the news of such discourteous treatment along the line, with the ever increasing increment of exaggeration which mouth-to-mouth tales always gather. One person acting discourteously can do more to start an agitation for public ownership of a private plant in these days, or do more to rouse criticism of a municipal administration than ten courteous persons can undo. Courtesy costs nothing but brings heavy returns on a small capital investment.

As an illustration of the damage that can be done by lack of courtesy the author will cite the case of a clerk in a municipal department not far from Philadelphia. This man was fond of smoking and chewing tobacco. His business training had been thorough and his work was accurate and met all the requirements of good bookkeeping. Part of his duties consisted in serving at the general counter in the absence of the chief clerk. He had been transferred from a position where he had but little to do with the general public, being in charge of shop and storeroom accounts. Within a few weeks after he had been transferred to the main office, complaints began to come to the mayor's desk, these complaints being based on the lack of courtesy shown by this particular man in the water department. Investigation demonstrated the fact that when ladies entered the office and had to be answered by this particular bookkeeper, they were spoken to gruffly, a cigar or cigarette which the man might have handy would frequently be deliberately lighted and no attempt made to divert the smoke from the faces of

the customers, and the entire manner of this man might easily be summed up in the familiar expression used sixty years ago, "the public be damned." Steps were immediately taken to remove the man but the odium brought on the water department by his action during the few weeks he was in the main office lasted for months, for we are human and do not easily forget such acts on the part of others, the old saying being true, "to forgive is human, to forget, divine."

Closely akin to the element of courtesy is affability. We might almost say that it is a part of courtesy. The telephone companies of the country advise us all to use "the voice with the smile," and there is good, hard sense in the advice. If the voice with a smile has been found by long experience to be of value in a large business, how much more the face with a smile should be able to accomplish.

"A soft answer turneth away wrath" comes to us from several thousand years ago, and few of us can give a soft answer without the accompaniment of a pleasant smile. In a town not far from New York one of the department officials having to meet the general public in large numbers has for years been spoken of as one of the most accomplished men in handling people who have grievances and who are determined to show the town that they don't intend to be stepped on and that the city employees will soon find out "who's boss," simply because he persistently and even aggressively smiles and keeps pleasant until the irate customer is forced to give way before that genial face, and in almost every case leaves with a smile on his own face. It is the intelligent use of "the smile that won't come off" that turns many an enemy into a friend of the business.

Another element of material value having to do with the personal factors in our business is accessibility. This applies more to the larger cities and towns than to the smaller places where everyone connected with the department office is generally found in one room. By accessibility in this case the author means the willingness to be approached by the general public and listen to the question or complaint which may be interesting a certain customer. This is not always easy to accomplish, or at least seems so to us on our busy days, but many people will judge our business by their treatment in this respect. To be told that Mr. Jones is busy may be all right the first time, but if the same story is given on a second and third attempt, the chances are that a sore spot is created which does not lessen with time, and Mr. Jones is censured un-

justly or justly because of his inability or unwillingness to permit the customer to take a few minutes of his time. There will be many days with all of us when many people come in to ask questions which might reasonably be answered by someone else in the department, yet the fact that such customers have been able to interview the particular member of the department whom they wished to see instead of being turned over to somebody else whom they regard as not the proper person to answer their particular inquiry, has benefitted the department materially. It may crowd some of the work into extra hours occasionally, but we are giving our time and talents to our department, and the little personal sacrifice involved counts much in the long run.

Other elements involving the personal side of the business which may be mentioned in passing are promptness in handling various items of department work when a customer's time is involved, and accuracy in making statements concerning the department and in all financial matters.

The last item on the personal side on which the author cares to touch is that of diplomacy. Difficult cases arise in many lines of activity in our business, and the wise manager will have so thorough a knowledge of his assistants that he will know who is the best one to handle a given case. We may have authority to force a certain situation and accomplish our ends by this means, but to do so may produce bitterness on the part of the aggrieved customer. It might be all right in law to send a negro workman to make an inspection in the house of a family known to resent contact with this race, but it will probably not cost any more to send a white man to handle such a case. It might be all right to send a laborer to explain why a hydrant is being placed in front of a beautiful residence, but in case of protest on the part of the owner, it would be the point of wisdom to send an assistant engineer in the case of larger departments or the superintendent himself in the case of smaller towns. It might be all right from the legal standpoint to call a man a thief when we feel that we have proved that a meter has been tampered with deliberately, and yet such cases are so difficult of absolute proof that a quiet man-to-man talk with the suspected party will probably produce admissions which could be obtained in no other way and lead to the adjustment of the case and full settlement of our money charges against the property, or make easy the prosecution of what might otherwise be a difficult case to prove in court.

It might be all right for us to tell a person that we were going to perform a certain function of our business because the law gives us the right to do it, and dismiss him with such a bald statement of the case, but by using a few words of explanation showing the necessity for carrying out this line of action in the way prescribed, and possibly including in such explanation the regret of the authorities that any one person should be inconvenienced, there will be no hard feeling left on the part of any fair minded man, the act of the department will be accepted as a necessary one, and such inconvenience as may be involved will be more easily borne because of the fair attitude of the department official.

Passing now to some of the physical elements affecting the relations of the department with the general public, the location of the main office is one of the foremost items. It is fundamental that the main office should be centrally located with reference to the population served, though it is not vital that it should occupy an expensive position on the main street of the city or town. The office should be attractive in general appearance and this element can be obtained without incurring heavy expense. If there is any question as to where lack of attractiveness shall exist, stress should be laid on making the interior attractive rather than the exterior. A bright, clean office, even though small, does much to make a favorable impression on customers. Judicious use of pictures of interesting features of the supply system, charts and illustrations of various kinds showing the details of the various activities of the department, and exhibits which explain without technical analysis the salient features of the department affairs should be included in the office equipment. In connection with this latter element the members of the department who must come in contact with the general public should understand the different features used as illustrations and should be able to explain all the important details of same. We should not take it for granted that what is perfectly plain to us or thoroughly understood by us, should be easily understood by the lay mind

By way of illustration, take the case of charts portraying the consumption of water compared with the number of meters in service and probably with the population of the city for a number of years. We read such charts easily and quickly, yet many people do not grasp the idea on which such charts are based and have difficulty in understanding why a line, which we usually refer to

as a "curve," rises or falls because some figures on one side or the other of the chart increase or decrease in a certain direction. Consequently the office force should be thoroughly coached in the meaning of the illustrations, so that they in turn may explain easily and clearly their meaning to any customer.

General knowledge of all department activities should be possessed by as many as possible of those connected with the department, in order that a customer requesting information shall not be passed from one to another seeking information. Those of us who are dealing with certain supply concerns in this country know how aggravating it is to call on the telephone, explain our wants, be referred to Mr. Smith, explain our needs in detail and be informed in dulcet tones that Mr. Jones can tell us about these matters, and on referring to Mr. Jones again to explain our desires, be informed by Mr. Jones that Mr. Johnson is the proper person to give us the information. This may continue until our patience is worn to a frazzle and we get tired repeating the formula which expresses our wants.

The conclusion of the whole matter is that our work is the service of the public, and must not be measured by financial standards alone.

THE SERVICE CHARGE—HOW CONSTITUTED[1]

By J. N. Chester

This paper may be regarded as a discussion of, or reply to, the report of the Committee on Meter Rates of the New England Water Works Association which has appeared during the last two years in the *Proceedings* of that Association; it is also a revision of a paper read by the author before the Pennsylvania Water Works Association at Atlantic City last October.

A well known author has defined the Service Charge, as "A Form of minimum charge made to cover the cost incurred by the utility in holding itself in constant readiness to render service without, however, delivering a single unit of service." Another author states that, "A popular fallacy regarding the ready-to-serve expense, is that it is limited to merely the meter or service line, which is far from the truth, as the ready-to-serve feature embraces the entire plant and extends back through the whole utility organization."

The Meter Rate Committee of the New England Water Works Association appears to have fallen into the pit pointed out by the authors above quoted, for they state that the service charge is made up as follows:

> First, the average amount of money invested by the works in the service pipe and meter.
>
> Second, the cost of reading meters, keeping of meter records, making out bills and collecting the money.
>
> Third, an amount which will represent the approximate average value to the works of the water that passes a domestic meter without being registered.

This confines the charge, with the exception of the addition for leakage, to the meter and service line only.

What constitutes a service charge and the ways of determining it naturally create a broad field for difference of opinion. The New England Committee in determining the ratios used in the discussion, started with areas of circles the same as meter sizes, which it tem-

[1] Read before the Four-State Section at Philadelphia on April 18, 1917.

pered with the ratio of the carrying capacities, as well as the maximum normal output of meters, and it arrived at nearly the same ratios as the author, wherein he started with the diameter of the service pipe and the meter, tempered this with the normal capacity of meters, the loss of head in service pipe, meter, and orifice of influx, as shown in the following table:

Relative demand of service lines and meters. Service lines assumed at 100 feet long from street main to center of maximum demand

Diameter of service pipe / Size of meter	½″ ½″	¾″ ¾″	¾″ 1″	1″ 1″	1¼″ 1½″	2″ 2″	3″ 3″	4″ 4″	6″ 6″
Type of meter	Disc meters					Rotary meters			
Capacity in gallons per minute	4	7	8	13	30	40	75	125	200
Capacity in gallons twenty-four hours	5,760	10,080	11,520	18,720	43,200	57,600	108,000	180,000	288,000
Loss of head in feet:									
Service pipe	27.00	19.00	25.00	19.00	11.00	6.60	2.92	1.85	0.58
Meter	7.00	16.00	3.00	2.30	5.00	6.00	8.07	7.00	4.60
Orifice of influx	0.34	0.20	0.27	0.22	0.23	0.13	0.09	0.07	0.04
Total loss of head	34.34	34.20	28.27	21.52	16.23	12.73	11.08	8.92	5.22
Relative demand	1.00	1.75	2.00	3.25	7.50	10.00	18.75	31.25	50.00

The relative final results as to ratios obtained by the author and the New England Committee are

	SIZE OF METER	NEW ENGLAND	AUTHOR
	inches		
One-half inch service	⅝		1.00
Three-fourths inch service	¾	1.0	1.75
	⅞	1.7	2.00
	1	3.0	3.25
	1½	6.0	7.50
	2	10.0	10.00
	3	20.0	18.75
	4	30.0	31.25
	6	60.0	50.00

With this ratio established, the New England Committee proceeded to build up the service charge for a ⅝ inch meter as follows:

In the above tabulation the $\frac{3}{4}$-inch service is used in conjunction with the $\frac{5}{8}$- and $\frac{3}{4}$-inch meters only; with all other meters the size service intended by the author should be the same diameter as the size meter given.

"First, 10 per cent of the average investment of the works in the service pipe and meter.

Second, $1 per annum for reading meters, billing, and collecting.

Third, $2 per annum for the probable value of unregistered water.

For a domestic service charge with ⅝ inch meter, the ordinary service charge may properly be $3 when the service and meter are paid for by the taker; $4 when the meter is furnished by the works; and $5 or $6 where both meter and service pipe are paid for by the works; the lower figure being used where the average cost of the service pipe is under $15 and the higher where it is greater than $15."

The service charge for larger size meters naturally is obtained by multiplying that found for the ⅝ inch size by the factors above given.

In the author's opinion, the New England Committee has established but a portion of the service charge, which might, with the exception of unregistered water, properly be styled the consumer charge, and he believes the service charge should be constituted of a consumer charge and a capacity charge, and that unregistered water should be accounted for in the output charge.

The consumer's charge may be defined as being made up of the cost which accrues to the plant due to each separate consumer, such as reading meter, repairing the meter and service line if owned by the utility, interest on the meter and service line, the keeping of accounts and making out, mailing and collecting bills.

The capacity charge should, in total for all consumers, including public and private fire protection, be the amount necessary to keep the plant ready for service and intact were not a drop of water delivered for the entire year, necessarily including interest on the fair investment and depreciation on the entire physical plant.

The cost of producing service, together with maintenance and profits, should be incorporated in the output charge, which will be discussed later.

Whether we constitute the service charge of one thing or another and regardless of what elements may enter into this makeup, the burden of this paper is to show, if possible, that the amounts set forth in the report of the New England Committee as ordinary proper service charges are inadequate, except in extreme cases, or at the best represent possible minimum amounts applicable in extraordinary cases only.

A reply to this assertion may be that whatever the service charge produces, the balance must be made up by the output charge,

which of course is the intention of any service charge. But the author believes the New England Committee neglected the fact that in many places the revenue from output charge is extremely variable and unstable, and unless it becomes the major source of income, it will too frequently occur, due to the ups and downs of prosperity, wet seasons and other causes too numerous to mention, that the revenue will at times become inadequate to meet the requirements expected of it.

Let it therefore be understood, that in the author's opinion, the function of the service charge is more to stabilize than to produce a revenue, which might all come from an output charge, if revenue so obtained was stable from year to year.

FIRE PROTECTION

Public. It has been stated before that the service charge included public fire protection. That the rate for this may be fixed by any of the methods above discussed is not claimed. Whatever the method of determining what the charge for public fire protection shall be, it should place the proper proportion of that burden on the vacant lot as well as the improved property, encourage the installation of a sufficient number of hydrants, and prevent, in the case of privately owned plants, the ordering by the municipality served of long lines of pipe without compensation.

Private. It is the author's opinion that the service charge should cover private fire protection only to such extent as the hazard thereby incurred to the water company shall warrant, the excess over this being distributed to a per sprinkler-head, per hydrant or per nozzle charge. The author hopes to see the day when this charge shall be tempered by the hazard.

OUTPUT CHARGE

The output charge may be defined as that part of the burden due to the cost of operating the plant, which includes fuel, supplies, maintenance other than depreciation, and salaries to more or less extent in controversy. The oft repeated statement that the proper return having been obtained through a service charge, the entire output may be sold at a fixed price unit, is, in nine cases out of ten, a fallacy, permissible only in districts where consumers are wholly residents or domestic. Even then it is open to question. The

nearer consumers are located with respect to the pumping station, the lower the cost at which they can be served. This would point toward a zone system of charges, varying with each foot the consumer is distant from the means of introducing the water into the mains. Each consumer who resides higher than the lowest consumer costs the water company more to produce the pressure necessary to render him good service; so, again, the rate should increase with every increase in elevation above the means of introducing the water into the distributing system.

Such refinement, however, would introduce endless complications and so common practice has ordinarily decreed that within a certain district, all consumers supplied by one pressure at the source or means of introducing water to the distributing system, shall be accorded the same rate.

In the output charge, a variation should be made and in this, in most cases, quantity consumed should govern price per unit of service.

To forestall attacks from the advocate of the principle that no water should be sold below cost, it may be stated that cost is susceptible of different interpretations and should be looked upon from the standpoint that a large consumer is profitable at any rate which produces a result that will add to the net revenue of the plant, even though the rate is below the average cost as built up by administration, operating, depreciation, interest and profit.

The principle adopted by many rate makers of first determining the high or unit price for small quantities to small consumers is wrong, and the minimum output unit price or charge to the largest consumer should be first determined. The following are a few axioms observed by the author in casting output charges.

A community with few or no industrial consumers may have but a single output charge.

Communities where a water supply is universally accessible to large consumers demand either a high service charge or an extremely variable output charge.

In casting a variable output charge the lowest unit price should be the maximum that conditions will permit, and the higher the low price is fixed the lower the high price.

Usually a railroad or some large mill or factory is the consumer to receive the low price, and his ability to produce his own supply and the cost at which he can obtain it is not only the feature that must

govern as to whether or not he is a consumer, but at what price the company or municipality can afford to furnish him a supply. This should be a trifle more than the unit price at which he can provide his own. Once this low price is fixed, the next larger consumer generally give less trouble, and the probable revenue from large consumers is soon ascertained. This total is subtracted from the whole amount to be derived from output charge, and the remainder can then be distributed to the commercial and domestic or small consumers in a consistent manner.

A few recently adjudicated service and output charges will serve to illustrate.

SIZE OF OPENING	BEAVER VALLEY, PA.‡	CITY WATER CO., SEDALIA, PA.	OHIO VALLEY WATER COMPANY, BELLEVUE
½ inch or ⅝ inch tap*	$4.60		
½ inch or ⅝ inch tap†	9.00	$6.00	$6.00
¾ inch tap	13.00	9.60	9.00
1 inch tap	24.00	12.00	15.00
1½ inch tap	48.00	30.00	30.00
		1¼″ 18.00	
2 inch tap	100.00	48.00	50.00
3 inch tap	200.00	90.00	110.00
4 inch tap	380.00	120.00	200.00
		5″ 168.00	
6 inch tap	840.00	240.00	440.00

* One opening only.

† More than one opening.

‡ Based on diameter of tap in main.

Output charge

	per 1000 gallons
Beaver Valley:	
For the first 1,000,000 gallons per annum	$0.10
For the next 9,000,000 gallons per annum	0.08
For all over 10,000,000 gallons per annum	0.06
City Water Company, Sedalia, Mo.:	
For the first 30,000 gallons per month	0.30
For the next 100,000 gallons per month	0.20
For the next 200,000 gallons per month	0.15
For the next 1,000,000 gallons per month	0.10
For all over 1,330,000 gallons per month	0.075
Ohio Valley:	
For all water used	0.12

The decision in the Ohio Valley case outlined the following:

Fair return, 7 per cent	$64,732.08
Annual operating expenses	63,500.00
Annual depreciation, ¾ of 1 per cent	6,935.58
Gross revenue	$135,167.66

This gross revenue to be collected by the company as follows:

From fire service	$27,035.53
From all other service	108,134.13

This last item was to be the sum of the service and the output charges, which, strange to say, applied to 1916 conditions, produced the following:

Output charge	$59,319.48
Service charge	40,824.23
Municipal and miscellaneous consumption	7,990.42
Total	$108,134.13

It might be also noted that it divides the revenue, other than fire protection, at approximately 60 per cent from output and 40 per cent from service charge.

The Beaver Valley rates were cast to produce a gross revenue of $135,950, of which $25,000 was set apart for public fire protection, and the remaining $110,950 was ordered distributed on the basis of 60 per cent for readiness to serve and 40 per cent for output.

A comparison between the ready-to-serve charge and private fire protection rates for different size openings imposed by the Beaver Valley decision may interest. They are as follows:

	DOMESTIC	FIRE
1½ inch	$48.00	$50.00
2 inches	100.00	75.00
4 inches	380.00	100.00
6 inches	840.00	175.00
8 inches		300.00

Sedalia, Mo., is a city where water is difficult to obtain. They have but two large industrials, the shops of two railroads centering there.

DISCUSSION

J. W. LEDOUX: The author has given a very valuable address on service charge, and the speaker is in entire accord with most of his conclusions. One point, which is very important, is that the service charge which should include a charge for fire protection and should be equal to the expense to the water company when no water is delivered to the consumer. This charge should be prorated on some such basis as the author outlined, the size or capacity per minute of the service pipe, or meter.

In his justification of selling water to large consumers below cost, the author must have in mind the condition where a company has an unlimited supply and it does not run any risk in selling a portion of this water below cost. The speaker's experience has generally been under conditions where the supply was limited, and even in cases where water has been taken from large lakes, the intake pipe and works have been so expensive to construct and maintain that the effect was practically to make the supply a limited one. Therefore, if the water company can sell its entire supply for, say, 10 cents per thousand gallons, and it has not yet reached its maximum obtainable revenue with its present plant, is it justified in selling a portion of its water for say 5 cents per thousand gallons? Beginnings are dangerous. When once a low rate is established for a water-works, the pressure is so great to maintain it as normal that the water company gets into serious trouble later, when, on account of encroachment on its supply or unprofitable business, it attempts to raise this rate. Under any circumstances, contracts at such low rates should be for short periods, and such consumers should be given clearly to understand that the water is being sold below cost on account of there being a surplus at that time.

The author makes use of a term engineers should avoid not only openly but in spirit. He says, certain rates should be based on what the "traffic will bear." It would be better to state, "the rates should be what the traffic should bear." Water companies should always act fairly with their patrons for two reasons, first, because it is just to do so, and second, it is better policy. It is of great commercial value to a water company to have a reputation for square dealing.

G. S. CHEYNEY: The previous speaker took exception to the author's statement, that certain rates should be based upon what the traffic will bear. As a matter of policy, no doubt, the suggestion that this term be avoided is good, as the use of this phrase appears to excite the public, the newspapers and the commissions very much like a red flag excites a bull.

"What the traffic will bear" appears to be generally accepted to mean the exploiting of the purchaser. It is curious that this interpretation of the term is generally accepted. In practice it has been just the opposite, and what the traffic will bear has been the consumer or shipper's greatest argument in securing rates such as they desired. The very basic thought of the principle is a rate which will create or develop the business and not one which will hamper or interfere with development. It is the principle which gives the greatest protection to the buyer, as it prevents rates being fixed which he could not afford to pay and in former times, before the days of commissions, it was practically the only principle considered in rate making. It is safe to say that 75 per cent of existing rates which are lower than warranted to bring a fair return on the value of the property, were originally made on this principle. In most cases it was sound business, as it enabled the company to develop the business which would increase its gross receipts without making a corresponding increase in its operating expenditures.

The courts and commissions are apparently very loath to openly admit that the value of the service, or what the traffic will bear, is a proper matter for consideration in rate making, and they go through considerable pretense of basing rates on the value of the property devoted to the service, but it is quite apparent to any one who follows these cases that what the consumer can afford or is willing to pay is the matter of predominating importance and practically governs rate making by these bodies. No commission or court would make a rate so high that it would prevent the purchaser buying, even though such a rate was required to produce a fair return on the investment, as shown by all the evidence and records before them. Such a rate would, of course, be an absurdity, as it would bankrupt the company.

If what the traffic will bear, or the value of the service, is not to be considered in rate making, the shipper, consumer or purchaser can have no logical place at a rate hearing before a court or commission, for otherwise the only matter to be determined would be a

fair return on the value of the property devoted to the service, and what the consumer or shipper could afford to pay would not be competent evidence.

Apparently the fundamental difficulty in rate making by governing bodies is that they are trying to ride simultaneously these two horses. The first is the old well-known steed, endorsed by the Supreme Court, known as "a fair return on the value of the property devoted to the service." This is a horse designed by man on a somewhat scientific plan. The second is a practical horse, sired by necessity and working on the theory that payment should be based upon the value of the service, or the price at which the seller and the buyer are willing to trade. This latter principle governs all commercial operations which are not publicly controlled and must ultimately govern the rate making by these bodies also, as a rate which is either too high or too low, as measured by this standard, will ultimately bankrupt the company. If too high it will "kill the goose that lays the golden egg," and if too low, the company will not secure sufficient revenue to meet its fixed expenditures.

"What the traffic will bear" will, like the poor, be with us always, whether we like it or not, but it may sound more pleasant to rechristen this and call it by a name which will sound better to the public. P. T. Barnum discovered many years ago that the "public like to be fooled," and there are no indications of humanity having changed in this respect.

ALLEN HAZEN: The paper on the service charge is a timely and welcome addition to the discussion of meter rates. The New England Water Works Association has recently adopted a standard form of meter rates. This followed the work of a committee extending over several years and a discussion of the proposed rates in preliminary form by members of the Association at several meetings. It is to be hoped that the author's paper is the beginning of a wider discussion, with a view to the ultimate general adoption throughout the United States of a uniform schedule of meter rates.

Among the suggestions that the author makes is one that a greater proportion of the whole annual budget should be carried by the service charge, and a smaller amount in the price per thousand gallons or output charge. He suggests particularly that such a transfer be made of that part of the budget which represents the capital charges on the supply works.

The division of the whole cost of service between the service charge and the output charge is, in the end, a matter of judgment. The proportion of distribution is also a matter of broad general policy. There is no one system of calculation or estimate which can be said to be always right. It is to be noted that the form of schedule adopted by the New England Water Works Association does not fix in any way this proportion, but leaves the matter entirely open to be fixed for each system, as may be thought best. The author's suggestion thus relates to a method of calculation suggested by the committee as a helpful one, and does not apply to the form of rate that has been adopted by the Association.

Taking up the author's proposition as it relates to these methods, the writer believes that there are two fundamental reasons which, in a majority of cases, will make it inadvisable to carry out to the full extent the proposed transfer.

The first reason is that if the matter is carried out to its logical conclusion, it puts too large a burden on the smallest takers. The writer thinks that the method of calculation proposed by the committee for reaching service charges puts about all the load on the smallest consumers that the business will stand, and he also believes that the method puts all the load upon them that is their fair share. About half of the whole number of takers in an average system use less than 100 gallons per day each. Ninety per cent of all the takers, including these, are supplied by $\frac{5}{8}$-inch meters. The service charges are graded according to the size of meter. No distinction in service charge is made between the smallest takers and the largest domestic takers using $\frac{5}{8}$-inch meters. When the service charge is considerably increased, both the smallest takers and the larger ones pay the same advance. As a matter of fact, the larger domestic takers ought to have their service charges increased more than the smaller ones. The most practical way of doing this is to grade the service charge according to the amount of output. To do this can only be accomplished by increasing the charge per thousand gallons, while keeping the amount of service charge within a limit that is not unreasonable from the standpoint of the smallest takers. This the committee has tried to do by fixing a service charge in such a way that there will be no probable loss in maintaining the service to any taker.

It may be that the service charge could be wisely increased somewhat above this limit in cases, but the writer raises the question

whether it is not a fact that increasing it to a substantial amount will put a load on the smallest takers that is not warranted and that is not just to them.

The second reason why the capital charges should not be transferred to the service charge is somewhat different in its nature. To justify this transfer it must be supposed that the works are provided throughout of adequate size to supply any quantity of water that will be required. This condition may be reached in a plant when it is first built and for a certain period thereafter, but some time it will be necessary to enlarge the supply works. When that time comes, or even when it is approached, and thereafter, it must be considered that the supply works are, or should be, larger than otherwise necessary for the purpose of taking care of the larger consumers.

In an ordinary water supply system, the wholesale takers use a very substantial proportion of the whole output. The primary function of the water works is to supply the domestic needs of a community and they are mostly represented by the smaller takers. Extensions of the supply works are primarily needed to take care of the larger or wholesale takers.

The investment of capital in works to supply increasing output is just as necessary to the business as paying operating costs. The annual charges on capital so invested are just as much a part of the cost of supplying water as are the operating costs. There may be exceptions, but the writer believes that ordinarily all of the capital charges on the supply works should be carried as part of the cost per thousand gallons of the water that is supplied.

J. N. CHESTER: Replying to Mr. Ledoux's criticism on the author's stand regards selling water to large consumers below cost, Mr. Ledoux should have made his statement read "below average cost." Wherein he says the author must have in mind conditions where a water company has an unlimited supply, the argument intends metered service, and where all consumers are metered it is difficult to conceive of the water supply being less than the demand. If it is not sufficient, an expenditure should immediately be made to so create it, and this expenditure should be taken into consideration in figuring the average cost and also in ascertaining whether or not the consumer adds to the net revenue. On the other hand, if the existence of a low-rate consumer using water in quantities jeopar-

dizing the sufficiency of the supply and the estimated cost of providing to meet the wants of this consumer will greatly increase the fixed charges, this consumer's rate, or the lower output rates, should be at once adjusted on the basis of the increased fixed charges, and if he remains a permanent consumer, the plant should be at once put into condition to meet the demand.

The author is pleased with Mr. Chesney's staunch support of the phrase "all the traffic will bear," but deferring to the criticism of Mr. Ledoux and numerous others, the author has changed this to read "the maximum that conditions will permit."

As for Mr. Hazen's argument that the plan of imposing a material portion of the burden on the ready-to-serve charge puts too large a proportion on the smallest takers, he is asked to reflect that "you cannot keep your cake and eat it." Unless a just proportion of the burden is placed on the smallest takers, the revenue will, at time of depression when the industrial and commercial use is frequently more than cut in two, in so far as a fair return is concerned, be found wanting, or in other words, the output revenue in prosperous times must not be taken as a criterion for the minimum years. Even the average of a number of years is an unsafe reliance, and the author's final opinion is that the rate of return can only be made stable through the medium of the service charge, which naturally warrants a lower output charge but thereby begets a larger number of consumers.

Both Messrs. Ledoux and Hazen apparently cling to the idea that a rate once established or a large consumer taken on at a low rate becomes a fixture to remain and under some conditions becomes burdensome. Not so from the author's standpoint. Under public utility regulation a new rate may be filed at any time that it is justified, and large consumers should always be given to understand that their rate is subject to change at any time that it may be found unprofitable.

THE RELATION OF THE RAILROAD TO THE CITY WATER PLANT[1]

By C. R. Knowles

During the year ending June 30, 1916 the Illinois Central Railroad Company purchased water amounting to over $100,000 from 34 water plants in Illinois alone. This is an average of nearly $3,000 per year paid each plant. At none of the points included in the above figures does the annual expense for water fall below $600 a year and at some points, Centralia for example, the expense amounts to over $12,000 annually. Using as a basis of estimate the water purchased by the Illinois Central in this state, the railroads of the United States purchase annually from city water plants over $10,000,000 worth of water. This represents no inconsiderable proportion of the revenue from the operation of these plants.

The consumption of water for all purposes by the railroads of the country is estimated to be nearly 700,000,000,000 gallons per year. Compared with this enormous figure, the water purchased from city plants is small, and it would appear that the railroads are undeveloped as a field for the sale of water. This brings up the question as to what should be the relation of the railroad to the city water plant. Should it be the same as the ordinary householder using only a few thousand gallons, or that of a large, long-hour, high-load-factor consumer, whose business permits utilizing the reserve pumping capacity, thereby increasing the efficiency of the plant.

The cost of supplying water may be divided into two charges; first, the fixed expense or cost of readiness-to-serve, which remains the same regardless of whether the plant is operated to full capacity or not; second, the operating expense, which varies with the amount of water pumped. Assuming the plant has ample reserve capacity the cost of furnishing water to the railroad or other large consumer will consist of the fuel, chemicals, oil, waste, etc. Any return in excess of the actual operating expenses for furnishing such water

[1] Read before the Illinois Section at Urbana on March 13, 1917.

may be applied to the reduction of the overhead expenses to other consumers.

Companies furnishing electricity for power are probably the most efficiently conducted public service institutions in existence. This efficiency is largely attained through operating the power plants to their full capacity by securing an output for the power produced through attractive rates to large consumers utilizing the off-peak load. The prevailing rates for electric power in Illinois are from 4 to 11 cents per kilowatt hour. Special rates for large, long-hour, high-factor consumers and discounts for off-peak service, however, bring the cost down to 1 and 1½ cents per kilowatt hour. The electric power companies have made these low rates for two reasons: first that the highest efficiency is attained when the plant is operated under full load, and second, from a realization of the fact that there is a limit to charges that may be made for electricity and that limit is reached when the cost of current equals the cost of steam or other power.

The same thing is true of a railroad water supply. The limit is reached in cost of water from city plants when the cost equals or is in excess of what it will cost the railroad to pump its own water. The railroad is in a position to say what the water should cost by reason of having a water department organization, and perhaps in this respect has a different relation to the water plant than other large consumers. The fallacy of a universal rate for water to all consumers regardless of consumption is recognized by most water works managers and sliding scales of rates are established in many instances. These rates are, of course, based upon all expenses, fixed and otherwise, and do not provide for differential treatment of large consumers where it is necessary to make certain concessions in order to hold the business or secure new custom.

No better exposition of the advantages of differential treatment of customers can be given than that of Messrs. Knowles and Scharff in their paper on "The Relation of Out-of Pocket Cost to Rate Making" in the *Proceedings of the Illinois Water Supply Association*, 1914, an extract from which reads as follows:

> There remains, then, only the second basis which seems to us proper as a reason for differential treatment of consumers—in order to lower the cost to other consumers by retaining custom which would otherwise be lost. How this works out may be very readily explained. Assume a small waterworks with a gross income, which must be collected when it is supplying 1,000,000 gallons

per day, of $35,000. Now suppose one large consumer using 100,000 gallons per day and paying $3500 per year should find that he could secure water elsewhere at a cost of $2500 per year, and should disconnect from the mains. The amount supplied would drop to 900,000 gallons per day; but interest, depreciation and maintenance would remain practically the same; it would still be necessary to have the same number of engineers and firemen; and the only saving would be a small amount of fuel, alum, hypochlorite, oil and waste, etc., which would certainly not be in excess of $1000 per year and would probably be a great deal less. So that the gross income to be raised might be reduced to say $34,000, all of which would have to be raised from other consumers. Now if all other conditions remained the same, and the rate for the large consumer were reduced so as to just hold his custom, when paying $2500 per year, the total gross income would still be $35,000 and the portion to be raised from consumers other than the large one would be $32,500 or $1,500 less than in other cases. Their rates could, of course, be correspondingly lower than would be necessary if the large consumer were lost. The advantage of such an arrangement to all of the consumers is obvious, and such differential treatment, if necessary to secure this advantage, would not only not constitute discrimination, as we have defined it, but would appear to be a plain duty of the water-works as a public utility.

In brief, it is to the advantage of all consumers that large, long-hour, high-load-factors consumers be retained. Differential treatment of them does not constitute discrimination, so long as it will result in advantage and saving to other consumers. Such concessions in rates, however, must not be greater than actually necessary to meet the competition of other sources of supply, as in any case, they must not be so great as to increase instead of decrease the income to be collected from other consumers. Thus, in the case cited above, if it were possible to get the business at $2500, any rate less than that sum would constitute discrimination. If it were really necessary in order to meet competition, any rate greater than $1000 per year would effect some saving for other consumers, and would be justifiable. A rate less than $1000, however, would make the amount to be collected from other consumers greater than if the large consumer ceased entirely to take service. This would certainly be discrimination under our definition.

In view of the facts as to rate making, as brought out above, it would appear that in many instances more attractive rates could be made the large consumers, such as railroads, rather than suffer the loss of business that will perhaps decrease the income to such an extent as to make it necessary to increase the rate for water furnished to the remaining consumers to make up the deficit. Aside from the advantage of the large consumer in keeping down the unit cost through absorbing a portion of the overhead or readiness-to-serve expense, a number of instances might be cited where the acquisition of one or two large consumers has made it possible to enlarge and improve the pumping plant and even construct new plants.

A writer in *Engineering and Contracting* of July 12, 1916, strongly advises the water works managers to cultivate a wider market for the sale of water by encouraging irrigation of truck farms and family gardens. He states further: "Water is a marketable commodity. Were as much ingenuity expended in marketing water as electricity there is probably not a water works plant in America that would not be able to double the quantity of water sold." Undoubtedly there are great possiblities in encouraging new uses for water, but as water is one of the prime necessities in the operation of a steam railway the market is already at hand and the water works manager would have but little difficulty in finding a market for the sale of water if he would apply the same methods that prevail along other business lines, namely, divide up the profits with the customer, if necessary to get the business.

DISCUSSION

E. MacDonald: The idea that a railway should get lower rates than anyone else seems entirely wrong. According to the author, the water department should make rates for other customers sufficiently high to pay all its overhead expenses, in addition to a fair profit above operating expenses, and then, because the overhead charges have been taken care of, the railway should be excused from paying its share of them, simple because, as he said, the investment has been made and reserve supply is obtainable and any additional business which would utilize the reserve ought to be given the lower rate.

The author mentioned the electrical industry and the methods of electrical men giving power consumers much lower rates than lighting consumers, because the plant originally was built for furnishing light and without any power load would be idle during daylight hours. The speaker thought that electrical installations can be found where exactly the reverse is true: where electrical plants were built solely for furnishing power. In such cases, why not say that any lighting load that could be taken on in the evening, when the power load is off, should receive a lower rate, because the power load is paying for all fixed charges, etc., and the lighting load merely utilizes an available reserve. A railway should not be given lower rates because it can and does utilize some very inferior waters.

Theodore A. Leisen: It would appear to the speaker that the suggestion for a special low rate for water furnished to the railroads

might very justly open the way for a charge of discrimination from smaller consumers, even assuming that the author advocates such low rate for all large consumers and not exclusively for the railroads. The speaker has in mind an instance in Wilmington, Del., where one leather manufacturer consumed water to the amount of approximately $14,000 per annum, a quantity equal to or greater that that of the largest railroad consumer in that city. If the water department had charged this manufacturer a much lower rate than smaller manufacturers in the same line of business, and there were several of them, it would have placed a handicap on the production cost of the small manufacturers and probably would have resulted in a justifiable charge of discrimination.

The conditions which cover supplying electric current in wholesale quantities for power and those for furnishing water are not analogous, for the reason that the electric light corporation can maintain a more even power load by supplying power current during the daylight hours when the lighting load is at its minimum, whereas the large consumers of water usually require their maximum quantity at the same time that the general consumption is at its maximum stage. In a system where direct pumpage is in effect, the load factor is thereby abnormally unbalanced, in contradistinction from the conditions governing the electric light plant.

The best system of metered water ratings is obtained by making a fair service charge on every metered connection, graded in proportion to the size of the meter, and then charging all consumers at the same unit rate for all water consumed. The service charge should be based on a proper proportion of the fixed overhead charges, plus the cost of reading and maintaining the meter, and the unit rate for water should be placed at the lowest possible figure consistent with the revenue requirements to cover production costs and other expenses which have to be met through the revenues.

This system has the merit of treating all consumers on the same basis and eliminates any question of discrimination, while it actually provides a gradually lowering rate in inverse ratio to the quantity consumed, through the virtual absorption of the service charge into the larger consumption figures.

W. J. SPALDING: The speaker approves Mr. Leisen's theory of dividing the charge for water into two elements, a ready-to-serve

charge which covers the fixed expense incurred regardless of the water consumed and proportioned to the size of the meter, and, in addition, a uniform rate for water. This method will automatically work out a different rate for each user according to quantity consumed. There may be some cases in which, as a matter of expediency, the water department would be justified in giving to a railroad company or other large user a special rate, but it would be very hard to show that they were entitled to it as a matter of justice. The author would like to have us assume that in the case of the railroad we are selling the surplus from our plant. What right have we to single out one customer and assume that the water he gets is surplus any more than that of any other customer? Such an assumption is arbitrary and cannot be defended on the grounds of equity.

C. L. KÖHN: Regarding the selling of water to railroads at a cheaper rate than to other consumers, it is essential for a city water plant to acquire large consumers. It would be quite a loss to lose a consumer paying the department hundreds of dollars annually. Every water department generally sees to it, or should do so, that its supply is adequate for the increase of consumption with the growth of the city. If large mercantile houses can and do find it profitable to do both a wholesale and retail business, why should not the same rule apply to the sale of water under certain conditions. It must be evident that a large consumer saves expense to the department for various reasons.

For instance, our householders' average yearly bills amount to $9. In order to receive a revenue of $3000 it would be necessary to have 333 small consumers. The cost of meters alone would be approximately $3000; the cost of installation of services and their maintenace, reading meters, collections, bookkeeping, etc., are also items to be considered. The sliding scale is the fair and proper way to sell water.

A franchise was granted the Western United Gas & Electric Company in Elgin, embodying the following clause:

> *Provided:* The company may supply gas at reduced rates to the Elgin National Watch Company and other wholly industrial concerns, whose unusually large consumption of gas under the conditions of delivery, in the discretion of the company may make such reduction as appears advantageous to said concerns.

This provision permits good business.

FORTY-FIVE YEARS' EXPERIENCE IN WATER WORKS[1]

By E. E. Davis

In September, 1872, I was employed in the capacity of walking boss in the water department of Richmond, Va., but as this was not exactly in my line, having served an apprenticeship at plumbing, gas and steam fitting and pipe work generally, I was given a force of men requiring the services of a general mechanic. In other words, my position was that of handy man around the store and shop. It was my purpose, after entering the service of the water department, to acquaint myself with hydraulics.

In the early days our service consisted of only one pumping station and one reservoir, about 44 miles of main varying in size from 1½ to 24 inches and an average daily pumpage of 2,400,000 gallons. The mains were of the character of those installed from 1831 to 1872, made of almost any kind of cast iron, some hard, some soft and some thin. During my forty-five years experience they have varied from the old to the newer style. Numerous breaks in the mains occurred from time to time and the most remarkable thing about them in the old days was we always had the worst in freezing weather.

All fire hydrants were of the compression type, with wooden or iron cases, and whenever the screws of the stems became worn, the lost motion caused the mains to burst when the hydrants were closed. The old wooden cases had to be made and put on in the best way possible. The hubs for the nozzles were not of the same size, and consequently it was necessary to cut holes in the wooden case with a compass saw to fit each one. Frequently when a main was repaired and the water turned on, the hydrant was left open for the air to get out, and if the men shut the hydrant off too fast, the pipe of course burst in another place.

The worst trouble we had was in the seventies with a compression type of fire hydrant. The firemen closed a hydrant at the bottom of a hill and the lost motion in the screw caused a water ram which resulted in the bursting of a 16 inch main, ⅝ inch thick, about 1000

[1] Read before the annual convention at Richmond, May 10, 1917.

feet away on the brow of a hill. We had to cut out this broken pipe and put in a new section. The leak was so large that a 50-foot roadway was nearly an inch deep in water for its entire width. This, of course, had to be fixed the same night the pipe burst. When we think of all the varieties of cast iron pipe, my trials and tribulations can be very readily understood.

Among the worst troubles were those caused in repairing pipe smaller than 4 inches in diameter. On several occasions, after these old pipe were dug up, you could, on taking the rust off, stick a hole in them with a pocket knife, yet these same pipe, before removing the rust, withstood a static head of from 20 to 50 pounds per square inch. None of the pipe was tested before being laid and none of them was coated, therefore you can imagine our difficulties. All pipes used after 1872 were tested at a pressure of 300 pounds per square inch and our troubles eased up with the tested pipe but the old ones continued to break. Quite a lot of the old pipe is still in use, but a great deal of it has been taken out and replaced by larger mains. No city has had any more experience with pipe of antiquated casting than Richmond.

In olden times we had no pipe jointers. Thanks to old Tom Watkins for his pipe jointers. All joints were run after rolls of potter's clay had been made to fit each joint, which was all right when the joints were dry but lots of trouble occurred by the clay blowing off if any water happened to be in them.

In my time we also had the old-style piston pumps driven by breast water-wheels 16 feet in diameter. Owing to their location, whenever we had high water in the river, they were put out of commission, causing the reservoir at one time to be dry, when fire engines were used to pump water into the mains from the canal. This service was of very little help, as the water was wasted by parties leaving their fixtures open. One reservoir supplied the whole city until 1876, when a new reservoir, having a higher elevation, was put into service, resulting in the breaking of some of the old pipes and causing trouble for me and the other foremen when the water was turned on from the new reservoir.

My colleague in outdoor work was an old man who had been in service since 1856, and we had a time as there were, in those days, none of the up-to-date improvements we now have. There was no machinery available for calking or tapping, nor were there any couplings made for lead pipe. Whenever a coupling was needed, it

had to be made to order. All connections for house supplies were the old-fashioned ferrules or tapping cocks driven into the main instead of being screwed in as is now done and in every case the water had to be shut off the main. You can no doubt appreciate my first experience in tapping, for these old drive ferrules had to be exact as to slightly bevelled holes and then driven sufficiently tight to hold. If hit too hard they would bounce out, in which case the drive end had to be filed to a smooth surface and carefully driven again. The last one of these ferrules was used in 1883, at which time I induced the superintendent to purchase a Hardesty tapping machine.

As I was just a little skeptical in using the machine, it was first put into operation under a bridge on a 4-inch pipe with a working pressure of 50 pounds. The next tap was on an 8-inch pipe under 85 pounds pressure, then on a 6-inch pipe under 30 pounds pressure. This machine was sent on thirty days trial, but performed the work so satisfactorily that the department purchased it.

Serious trouble was encountered when a hard pipe was found and we were sometimes required to dig to another pipe soft enough to tap. Then, again, the drill would go through the shell of the pipe and stall, leaving a hole of about $\frac{1}{2}$ inch, in which case the main pipe had to be shut off and a brass plug driven into the hole All ends of cast iron pipes and specials 6 inches and under were plugged up with wooden plugs.

When a pipe split we had to cut out a piece and put in another section with a solid sleeve, for there were no split sleeves in those days. For all taps larger than 1 inch the main had to be cut and a special fitting put in. This was quite a job, as the water often leaked through the old valves and it was something of a problem to get rid of it. This we would often do by using a piece of hard twisted rope driven into the bell before the lead could be poured. We were not fortunate enough to have lead wool at that time. With the improvements since 1883 the water-works man has had a comparatively easy time, considering his troubles of the years before.

I shall never forget the first geared valve placed in service, used for the purpose of separating the high from the low service. On the day of its installation, I was called about 9 p.m. to the low reservoir, as it was about to run over, and remembering this particular valve, I realized that instead of turning the small pinion, only the main stem was used to shut down the valve.

I shall never forget my first experience in demonstrating the difference between flat or ordinance and meter rates. It occurred in connection with the bill for a livery stable for which the flat rate was $67 per annum. A meter was purchased and put on the service and instead of the bill being $67 per annum, the meter showed that it should have been $125 at 25 cents per one thousand gallons. My next experience was with a water motor at a restaurant, used only for driving fans during meal times. This motor was guaranteed not to use much water, but unfortunately for the proprietor of the restaurant, the bill became so large that he abandoned the motor and used clock fans, electrically driven fans at that time being unknown. A meter registered this service and the bills ranged from $10 to $25 per month.

More trouble came when the general installation of meters was first talked of, as all connections were straight pipes and ours a hilly city. During very cold weather the gauge at the office sometimes went down to almost nothing, occasioned by nearly every consumer leaving fixtures open and the water running to prevent frozen pipes. In 1895 the council appropriated $15,000 for the purchase of meters, which were installed on the lower parts of the service, and during the next winter the gauge showed 19 pounds instead of standing at nearly zero during freezing weather. The average pumpage per day in 1894 was 12,510,604 gallons through 85.09 miles of pipe, while in 1916 the average pumpage was 13,400,000 gallons with 80 per cent of the taps metered and with over 225 miles of mains.

My experience with pumps has been varied. In 1909 we abandoned all the old piston pumps at the old station and having only nine water-power pumps at the new station, which were not sufficient to keep up the supply, I took up the question of motor-driven centrifugal pumps, and after looking as far as possible into the efficiency of this kind of pump, finally decided to try them. We installed four such pumps of 4,000,000 gallons capacity each and found them to be very satisfactory.

My position from August, 1886, to January, 1908, was that of assistant superintendent and as such I was required to perform all the clerical work of the general office, which brought me into contact with all the water consumers to answer all sorts of questions and look into and report on all complaints. Having been one of the foremen before this time, I naturally had a deep interest in the out-

side working of the department, and was ready at all times to render any service in my power, not only to the superintendent but to any of the foremen or subordinates.

The work of constructing our settling basins was commenced in 1905 and completed in 1907. After my election as superintendent, in 1908, the flume conveying water from the basins to the pumps, 5000 feet away, was completed in the fall of 1909 and clear water pumped into the reservoirs and standpipe. My experience in clearing the water was limited, but as there was in the employ of the water department a very capable chemist, who experimented for over a year between the time of completing the basins and supplying water to the pumps, we had a very fine, clear and wholesome water.

During the past winter a 6-inch pipe, suspended under a big bridge and supplying 250 dwellings, froze throughout. This was the most remarkable thing I ever heard of, especially as it happened at 3 o'clock during the day, an hour when nearly everybody was using water for dinner. We had several other pipes exposed, none of which froze. I cannot understand why this should have frozen when water was running through it, unless due to exposure to the wind and a temperature of 4° above zero. It was my first experience with a pipe freezing with running water.

THE CHLORINE CELL INSTALLATION OF THE MONTREAL WATER AND POWER COMPANY[1]

By F. H. Pitcher and James O. Meadows

The sterilization of public water supplies with chlorine or chlorine compounds, either as an adjunct of filtration or as a sole method of purification, is now standard practice, and this method is well understood, but the production of electrolytic chlorine and the application of the gas, so produced, to the water to be purified is of rather recent date, and, except in a general way, is but little understood by the water works fraternity. The electrolytic cell installation of the Montreal Water and Power Company has been in service since the first part of the present year, a period hardly long enough from which to gather average operating results, but during the time that the plant has been in service considerable information and data have been secured that are of interest.

HISTORICAL SKETCH

The fact that common salt can be broken down or decomposed into its elements, sodium and chlorine, by electrolysis, has been known practically since the discovery of the galvanic cell, but the commercial application of this principle was impossible until the dynamo was developed, and even after this was accomplished, many difficulties had to be overcome to perfect an electrolyzing equipment which would efficiently and effectually separate the products and at the same time withstand the corrosive action of the chlorine gas. Numerous types of electrolytic cells, or decomposing chambers, have been evolved and perfected to a degree, but only a few have been even a partial success commercially.

In its simplest form an electrolytic chlorine cell is a tank or chamber, composed of materials that will resists chlorine and containing brine in which a positive and a negative electrode are im-

[1] Read before the Chemical and Bacteriological Section at the Richmond Convention, May 10, 1917.

mersed. Upon the passage of an electric current through the cell, chlorine gas is liberated at the positive electrode, or the anode, and simultaneously metallic sodium is released at the negative electrode, or the cathode. This metallic sodium immediately combines with the water in the brine, forming caustic soda and liberating hydrogen gas. The momentary products from the cell are, therefore, chlorine gas, a weak caustic solution, and hydrogen gas; but the chlorine gas and the caustic soda immediately combine to form sodium hypochlorite or so-called sodium bleach. Cells of exactly the type described have been and are now sold for laundry use, but they cannot be employed when a complete separation of the products is required. Furthermore, this type of cell can produce only a weak bleaching solution, and that inefficiently, because after the sodium hypochlorite reaches a certain strength, it is in turn decomposed by the electric current, making the process retroactive with the damaging result that the oxygen in the sodium hypochlorite combines with the carbon of the anodes to form carbon dioxide gas.

From the foregoing it is obvious that to obtain a perfect cell for the production of chlorine gas, the chlorine and the caustic soda which are the primary products of electrolysis must be prevented from recombining. To secure this separation of the products, four distinct lines of development have been followed:

1. By the insertion of a permeable diaphragm between the anode and the cathode.

2. By employing a mercury cathode which is alternately the cathode in the electrolyzing compartment of the cell and the anode in an adjoining compartment where the amalgam of metallic sodium and mercury is decomposed by water.

3. By placing the cathode under the anode and depending upon the stratification of the electrolyte which occurs due to the different densities of the brine solution and the caustic solution surrounding the immersed cathode.

4. By the use of a fused salt electrolyte and a molten lead cathode.

Only the mercury and the diaphragm type have survived commercial exploitation in this country on account of the inefficiency and cost of maintenance of types 3 and 4.

The several forms of diaphragm cells which have been commercially operated consist of two groups:

a. Cells with submerged diaphragms and cathodes.

b. Cells in which the electrolyte comes in contact with one face only of an unsubmerged diaphragm.

Very early in the history of electrolysis, Le Sueur, Gibbs, Crocker, Nelson and others conceived and operated cells of the submerged diaphragm or first group. Le Sueur employed a horizontal diaphragm and Gibbs employed a circular cell with a vertical diaphragm.

The unsubmerged diaphragm group is in turn subdivided into the two classes of permeable and impermeable diaphragms.

All of the permeable diaphragms for both the unsubmerged and the submerged group of cells are composed of asbestos paper or cloth, disposed in the cell in such a manner than they separate it into two distinct compartments, designated as the anode compartment, into which the saturated brine is introduced and where the chlorine is formed, and the cathode compartment, where the caustic soda is formed.

With cells of the submerged diaphragm group it is possible to a large extent to keep the chlorine gas and the caustic soda separated by maintaining a liquor level in the anode compartment higher than the level in the cathode compartment, thus inducing a continuous flow from the anode to the cathode chambers. Nevertheless, by osmotic action and mechanical interchange through the diaphragm, the salt caustic liquor from the cathode compartments invades the anode compartment and there combines with the chlorine to form sodium hypochlorite, which results in the loss of these two products and causes a rapid disintegration of the anode, as previously noted in the description of the laundry cell.

Cells of the submerged diaphragm type operate in practical service at not more than 85 per cent current efficiency (excepting only the Billiter-Siemens cell), with a maintenance which is in direct ratio to their lack of efficiency, because the less efficient the cell, the more hypochlorite is formed in the anode compartment with the consequent shortening of the life of the anodes.

Cells of the submerged diaphragm type operate with reasonable efficiency during the first few weeks of service after a new diaphragm has been inserted, but as the age of the diaphragm increases, it becomes less permeable and accordingly more effective as an osmotic vehicle for the contamination of the anode by the products of the cathode compartments.

With cells of the second group having the diaphragm immersed on one side only, the above described contaminating influences are

entirely eliminated, because there is no large body of caustic liquor present in the cathode compartments since the cathode liquor is withdrawn as fast as it is formed. It follows that in actual service, cells of this type closely approximate theoretical current efficiency with a resulting increased output and a longer life than can possibly be attained by cells of the submerged diaphragm type.

The Allen-Moore cell as installed by the Montreal Water and Power Company is of the unsubmerged diaphragm type and is guaranteed to have a current efficiency of not less than 92 per cent.

DESCRIPTION OF THE INSTALLATION

The chlorine cell installation consists of the following main parts; a salt storage bin having a capacity of 40 tons of salt, the brine saturating and purifying equipment, two 15-horse-power motor-generator sets, four chlorine cells, and the silver ejectors and distributing lines for applying the chlorine water to the water to be treated.

The brine saturating and purifying equipment consists of the following parts; three vertical galvanized iron saturators, 27 inches in diameter by $6\frac{1}{2}$ feet in height, provided with a spray system at the bottom and an outlet 6 inches from the top; two concrete reaction tanks having a capacity of 82 cubic feet each. These tanks are built with sloping bottoms and are provided with a pipe grid for air agitation. Two sand filters are provided for filtering the purified brine, which passes from the filters to the two concrete storage tanks having a capacity of 276 cubic feet each.

The distributing lines for applying the chlorine water to the water to be treated are 1-inch chemical hose lines, and the chlorine gas is injected into the water by means of a silver ejector, which maintains a 4-inch vacuum on the chlorine cells and takes the gas from the chlorine main through the ejector to the distributing lines.

Each of the four electrolytic cells is a standard 600-ampere unit and is 7 feet long by $20\frac{3}{8}$ inches wide. Each cell is provided with Atcheson graphite anode plates, and pure wrought iron perforated cathode plates. As stated previously the Allen-Moore cell is of the unsubmerged diaphragm type and uses asbestos paper for the diaphragm material. Unlike several other types of electrolytic chlorine cells, the cell box is made of concrete, properly protected at the surface to withstand the action of the chemicals.

The cells are connected in series and are provided with short-circuit switches or cut-outs. The voltage carried on each cell is approximately 3.3 volts, and each cell is capable of producing 32 pounds of chlorine per twenty-four hours.

To prepare the brine solution, a small quantity of water under pressure is allowed to flow in at the bottom of the saturators. The

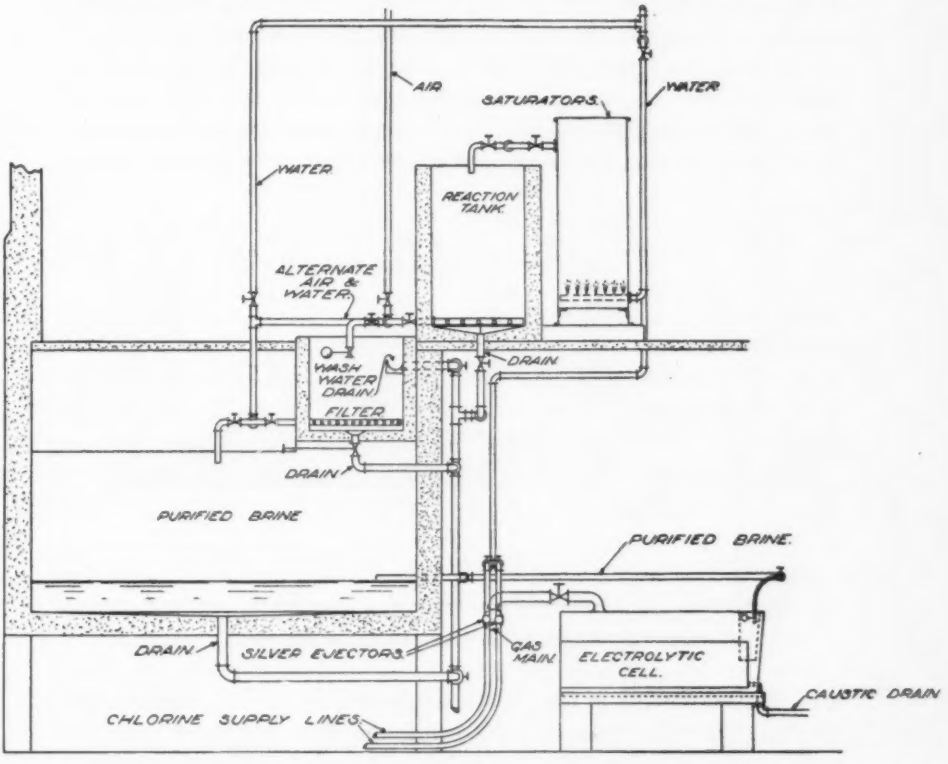

FIG. 1. BRINE SATURATING AND PURIFYING EQUIPMENT

saturators being charged with salt, a saturated solution of salt is delivered to the two concrete reaction tanks. A sufficient quantity of soda ash is added to the brine in the reaction tanks to combine with the calcium and magnesium salts present in the brine, and the contents of the tanks are agitated for one-half hour to insure complete mixing of the soda ash solution with the brine, and also to hasten the reaction. The solution is then allowed to remain in a

quiescent state for one hour to allow the precipitate formed to settle, when the solution is filtered through the sand filters into the purified brine storage tanks. A sample of the purified brine is taken and titrated for residual alkalinity, which determines the amount of hydrochloric acid necessary to add to neutralize the alkalinity and leave a residual acidity of about 0.01 per cent. It is necessary to have the electrolyte slightly acid to prevent the formation of hypochlorites within the cell, and the subsequent loss of cell efficiency.

The cell or current efficiency is computed from the cell flow of caustic liquor, the amount of caustic produced, and the current used to effect the dissociation. The flow of caustic liquor is measured for a certain period and computed as liters flow per hour,and at the

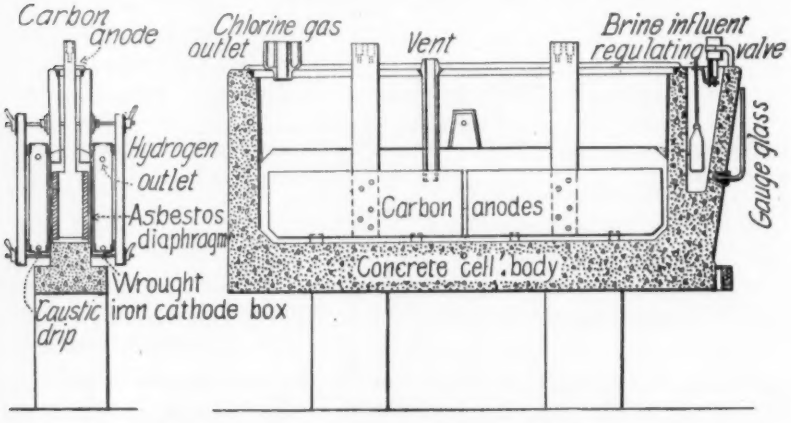

FIG. 2. SECTIONS OF CELL USED AT MONTREAL

same time a portion of the caustic liquor is titrated with normal acid to determine its strength. Knowing the flow per hour and the amount of caustic per liter the number of grams of NaOH produced per hour can be easily determined, which figure is known as the actual caustic production.

The number of amperes passing through the cell multiplied by 1.49 grams (theoretical NaOH production per hour per ampere) will give the theoretical caustic production, and this result, when used as the divisor, and the actual caustic production as the numerator will give a product which, when multiplied by 100, will be the percentage current efficiency of the cell. Also as the amount of caustic produced is to the amount of chlorine produced as the

atomic weight of NaOH is to the atomic weight of chlorine, the amount of chlorine produced can be easily determined. The amount of chlorine produced can also be determined by direct titration, and this chlorine assay will act as a check on the first determination. The average operating current efficiency of the cells has been maintained so far at about 93 per cent.

COST OF CHLORINE PRODUCTION

Annual cost of producing 90 pounds of chlorine per day or 32,850 pounds per year

Salt at $8.00 per ton, delivered	$500.00
Power, 15 H.P., at $30.00, flat rate	450.00
Labor and superintendence	500.00
Interest at 6 per cent on capital cost	300.00
Depreciation, 15 per cent	750.00
Total	$2,500.00

Three out of the four chlorine cells furnish the requisite amount of chlorine for sterilization, yielding 90 pounds of chlorine gas per twenty-four hours or 32,850 pounds per year, making the cost of chlorine produced 7.6 cents per pound.

The annual cost of sterilization previous to the installation of the chlorine cells was as follows:

Chloride of lime at 3.75 cents per pound	$4,105.00
Interest at 6 per cent	150.00
Depreciation at 5 per cent	125.00
Labor and superintendence	500.00
Total	$4,880.00

As the amount of chloride of lime required was 300 pounds per day or 100 pounds of available chlorine, the cost per pound was 13.4 cents, or 5.8 cents per pound more than chlorine produced by the electrolytic cells.

With normal market conditions the annual cost of the two forms of treatment would be approximately the same, if one did not consider the general depreciation that chloride of lime causes about a water purification plant.

OPERATION

An electrolytic chlorine cell functions at its best when under a constant current load, and for this reason it is good practice not to vary the load, or if varied to bring about the change gradually. Variations in load cause a considerable deterioration of the diaphragms, with a consequent loss in cell efficiency. For this reason automatic control of the chlorine production from an electrolytic cell is not practical, and for the treatment of a large volume of water, without appreciable variations in volume, automatic control is not required, for the dosage can be regulated for the maximum requirements without causing tastes or odors during the minimum consumption periods. The three cells required to supply the chlorine consumed for sterilization are operated with a current load of 500 amperes and 13 volts. The electrolytic cells require very little attention and up to date have given excellent satisfaction.

The caustic liquor from the cells contains about 12 per cent of sodium chloride and about 10 per cent of NaOH. No recovery of the salt and caustic is attempted, because the amounts of these two chemicals produced are so relatively small that their recovery would not be economical. For large installations the recovery of the salt and caustic is a regular feature of the process, the salt recovered being used over again, and the caustic is concentrated and sold as liquid caustic.

CONCLUSIONS

The chlorine cell installation was adopted because of the saving effected over the present high price of chloride of lime and inability to secure this chemical with any degree of certainty, and also because common salt is very much easier to handle around a water purification plant, and its use in the chlorine cells does not cause the general deterioration about the works that the use of chloride of lime does. Over-dosage with chlorine does not cause the trouble that chloride of lime over-dosage does, because odors and tastes are not present to the same degree.

The short experience at Montreal with chlorine cells for the sterilization of a public water supply indicates that an installation of this kind is perfectly feasible for large water supplies where the cost of power is not excessive.

DISCUSSION

S. B. APPLEBAUM: The paper suggests an economical application of the used brine solution from the regeneration of permutit water softening filters. This regeneration consists in passing a solution of brine slowly through the zeolite during the night. This brine leaves the filter just as clear as when it entered and the latter half of the brine is sufficiently free from calcium and magnesium chlorides to be entirely suitable for electrolytic purposes. There are several textile mills employing the used brine solution in this way, applying the resulting sodium hypochlorite for bleaching.

In a municipal pumping station where a permutit plant is used to keep scale and mud out of the boilers, the used brine liquor is electrolyzed and the sodium hypochlorite is sold to a hospital as a disinfectant. The receipts from these sales pay for most of the operating costs of the softening plant. The paper suggests the possibility of operating permutit plants in pumping stations by using the brine electrolytically as part of the sterilization process.

MAYO TOLMAN: The water supplies of a few West Virginia towns are disinfected by electrolytic bleach manufactured by the so-called Hargraves-Bird process, controlled in this country by the West Virginia Pulp and Paper Company. Each cell is 10 feet long, 5 feet deep and 15 inches wide. It is fitted with six anodes and two cathodes. The anodes consist of copper bars into which are leaded six carbon rods 2 inches in diameter, which are embedded in neat cement until but an inch of the rods projects on either side. Two-inch holes are drilled through disks of crucible carbon which are forced over the ends of the rods, giving a much greater area of contact of the carbon with the brine solution in the cell. These anodes, which weigh about 400 pounds apiece, are suspended in the center of the cell from a busbar that extends overhead. The cathodes consist of thin sheets of ground asbestos and cement, backed by perforated copper plates. They are of such size as to cover the entire sides of the cell, to which they are clamped by arched cover plates.

A steady stream of brine of a specific gravity of 2.6 Baumé, is introduced into the cell, where it is broken down into sodium and chlorine by an electric current of $4\frac{3}{7}$ volts and 27 amperes. The sodium passes through the diaphragm formed by the cathodes and is

treated with steam and carbon dioxide, forming sodium carbonate, used in the paper industry. The chlorine is sucked by powerful fans upward through towers of terra cotta pipe into which lime water is sprayed. The bleach liquor or chlorine water thus formed contains about 19.5 parts of available chlorine to the liter; that is, 55 gallons of the liquor is approximately equal to 24 pounds of 37 per cent hypochlorite of lime in the solid form. The liquor is readily handled in special bronze pipes and is a very excellent disinfectant for water sterilization purposes. In fact, on a number of rather extensive tests it has been found, part per part of available chlorine, to be far superior to the hypochlorite of lime prepared from the solid.

PUMPING STATION COST AND EFFICIENCY RECORDS[1]

By Mark Wolff

In a paper entitled "Interpretation of Water Works Accounts" read before the last annual convention, the author, in referring to modern accounting systems for water works, stated: "It was planned to illustrate or describe a set of records for office and field, including pumping station efficiency data," but these records were omitted for lack of time. The present paper is prepared in response to requests for the pumping station cost and efficiency records previously omitted.

The engineering and accounting records described herein have been in use by the water department of the city of New York for the past four years. Their importance is shown by the fact that the largest item of expenditure by the department is for operation and maintenance of pumping stations. There is spent annually upwards of $4,000,000 for the operation and maintenance of the city's present water supply system. Over one-third of this sum is spent for the 50 low-pressure pumping stations in the five boroughs comprising the greater city.

When the burden of increasing taxation became so great that it was reflected in the efforts of administrative officials to reduce the budget, the water department naturally directed special attention to its largest single expenditure, pumping stations. Since about 70 per cent of the total cost of operating the 50 stations was expended for the Borough of Brooklyn, in which 31 stations are located, this paper will be limited to a consideration of the economies effected in that borough, in an endeavor to prove the value of the records in question.

The cost and efficiency system was not installed solely for the purpose of effecting immediate economies. On account of the relatively high cost of operation of the Brooklyn water system, where all water has to be pumped, it was planned to introduce the cheaper

[1] Read before the Richmond convention, May 8, 1917.

gravity supply of the new Catskill system just as soon as it became available. The urgency of this plan will be appreciated from the following comparison of the additional outlay per million gallons required to utilize the two supplies.

	per million gallons
Catskill gravity supply	$0.50
Brooklyn pumped supply	17.20

These figures, of course, do not take into account the heavier capital expenditures necessary to provide a gravity supply instead of a pumped supply. The comparison is made from the standpoint of cost of operation only, on the assumption that the capital expenditures for the Catskill system were necessary in any event to insure meeting the increasing demands of the city in the future. With the completion of each section of the Catskill system, the new supply was gradually introduced in the different boroughs. Some of the stations were shut down before others. The institution of these cost and efficiency records, then, was also for the purpose of enabling the department to determine intelligently which stations were the most expensive to operate in point of performance, so that such stations might be shut down altogether and others manned and held in reserve, thus effecting the greatest economies possible.

Further, it was estimated that after shutting down the entire Brooklyn pumped supply, the combined yields of the old Croton and the new Catskill (Esopus) systems will be insufficient to meet the increased water consumption of the city estimated for the year 1922. In that year, it may be necessary to start the gradual resumption of pumping. The gradual reintroduction of the Brooklyn pumping stations, it is estimated, will continue until about 1928. The order in which the stations should be brought back into service would again be determined from the cost and efficiency data. It is likewise estimated that the discontinuance of pumping will be repeated again about 1929, with the introduction of the projected Schoharie development, and again gradually resumed commencing about 1933. The dates mentioned in connection with the discontinuance and resumption of Brooklyn pumping in the future are estimates based upon normal increase of population. For our present purposes, their accuracy is immaterial. The fact that the second resumption of pumping may not commence until say 1940 instead of 1933 does not affect the number of times stations will

ultimately have to be shut down and later resumed. With the introduction of a new supply, particular stations will be shut down. On the other hand, the subsequent failure of the new yield to keep pace with increasing demands will necessitate their resumption. The changes in each case will be dictated by the data furnished by the cost and efficiency records described herein.

The purpose of these records is, then, twofold, as follows:

First. To determine where economies can be effected in cost of operation and maintenance

Second. To enable the department to contract and expand its present Brooklyn system in a way which will be consistent with economy and efficiency.

The economies already effected in cost of operation and maintenance of the Brooklyn pumping stations for the three years ended December 31, 1915, are shown in the accompanying table.

Comparative cost of operation and maintenance, Brooklyn pumping stations, 1912 to 1915

YEAR	TOTAL PUMPAGE	TOTAL COST	COST PER MILLION GALLONS PER FOOT	AVERAGE DUTY, MILLION FOOT-POUNDS PER 100 POUNDS COAL
	million gals.		*cents*	
1912	110,406	$1,115,820	9.4	37.9
1913	106,284	996,038	9.0	40.2
1914	117,043	953,423	7.6	42.8
1915	113,973	908,666	7.9	42.3

Annual Increases (I) or Decreases (D)

PERIOD	TOTAL PUMPAGE		TOTAL COST		COST PER MILLION GALLON FEET		AVERAGE DUTY	
From To	Absolute	Per cent	Absolute	Per cent	Absolute	Per cent	Absolute	Per cent
1912–1913	(D) 4,122	3.8	(D) $119,782	10.7	(D) 0.4	4.3	(I) 2.3	6.1
1913–1914	(I) 10,759	10.1	(D) 42,615	4.3	(D) 1.4	15.5	(I) 2.6	6.5
1914–1915	(D) 3,070	2.6	(D) 44,757	4.7	(I) 0.3	4.0	(D) 0.5	1.1

It will be seen from the above that the reduction in the cost of operation and maintenance in 1913 is considerable, about $120,000, or a saving of 10.7 per cent in 1912 costs. The fact that 1913 was the first year in which the efficiency system was in full operation may be the explanation for this large reduction in costs. The de-

crease in 1913 pumpage, 4122 gallons, (3.8 per cent of 1912) combined with the first factor of reduced total costs, shows a decrease of 0.4 cent in cost per million gallons raised one foot. The average duty, the principal factor of which is coal, shows an increase over 1912 of 2.3 points, about 6.1 per cent. Although the saving in operating costs for the next year, 1914, was not comparatively large, the total being $42,615 less than that of 1913, it will be seen that considerably more water was pumped, 10,759,000,000 gallons, or 10.1 per cent more than in 1913. Combining these two factors we find a decrease of 1.4 cents per million gallons per foot, or a decrease per unit of 15.5 per cent from the results of the preceding year. This indicates that the figures for 1914 were decidedly more satisfactory than the improved results of 1913, which showed a decreased cost per unit of only 4.3 per cent. The coal efficiency likewise shows improvement to the extent of 2.6 points increase in average duty. The reduction of unit cost per million gallons per foot from 9.4 cents in 1912 to 7.6 cents in 1914, shows a saving of nearly 20 per cent. The advent of the new (present) administration, which was quick to appreciate the value of these records, no doubt was responsible for the good showing. Although the results for 1915 did not reflect improvement over 1914, they were almost as good as for the previous year. This is considered satisfactory, in view of the practical maintenance of 1914 standards in the face of increasing prices paid for labor, materials and supplies. As the European war has played general havoc with prices of labor, materials and supplies, and particularly with the cost of coal, it will be necessary to make allowances for this abnormal condition when making comparison of 1914 and prior figures with operating costs for 1915 and subsequent years.

As to the savings to be effected in intelligently contracting and expanding the Brooklyn system with the aid of these records, the annual economies will be governed by the actual new gravity supplies available and the increasing water demands of the city in each year. In this connection, it is stated by Commissioner William Williams:

> All of the 33 pumping stations in the boroughs of Brooklyn and Queens and all but one in Richmond will be placed in reserve, and thereafter the operating expenses of the department will be reduced by over $650,000 per annum, this after due allowance for maintaining and operating the Catskill system.

THE CITY

STATION No.....

DEPARTMENT OF WATER

ENGINE

STATION .....

MONTHLY REPORT

SUMMARY OF RECORDS FROM DAILY REPORTS

Day of Month	No. IN USE		Services in use R, T, C, D-S.	FEED WATER		Auxil's Running *No. in Use Multiplied by No. of Hrs.*	Mixture of Coal and Sizes	Coal Burned in 24 Hours *Pounds*	Water Pumped in 24 Hours *Gallons*	Total Lift *Feet*
	Boilers	Engines		Cubic Feet to Boilers in 24 Hours	Average Temp. *Deg. F.*					
1	2	3	4	5	6	7	8	9	10	11
							(85) Previous Local Efficiency Standards to be Surpassed, viz:			

THE CITY OF NEW YORK

DEPARTMENT OF WATER SUPPLY, GAS AND ELECTRICITY

ENGINEERING BUREAU

MONTHLY REPORT—PUMPING STATIONS

FROM DAILY REPORTS				ER	
Coal Burned in 24 Hours *Pounds*	Water Pumped in 24 Hours *Gallons*	Total Lift *Feet*	Million Gallons Raised One Foot High	Million Gallons Raised One Foot High Per Pound of Coal	HORSE Total of Water Cylinder Per Minu
9	10	11	12	13	14
ous Local Efficiency Standards to be Surpassed, viz:					

REPORT No.....

.....MONTH..... ENDING.....191.....

EFFICIENCY RECORDS				SUPPLIES USED				
HORSE POWER		Total Heat of Steam at Boiler Pressure	Equivalent Evaporation From and At 212° Fahr. Per Pound of Coal	Cylinder Oil in Gallons	Engine Oil in Gallons	Grease in Pounds	Waste in Pounds	Out-door Temperature at 8 A. M.
Total of Water Cylinders Per Minute	Lbs. Coal Per Water H. P. Hour							
14	15	16	17	18	19	20	21	22

The commissioner does not include depreciation, nor is this item included in any of the foregoing figures. Steps are now being taken to incorporate depreciation in future costs.

Incidentally, it might be added that should the Board of Aldermen approve the department's plans, further economies will be effected with the extension of universal metering. It is estimated by Deputy Commissioner Delos F. Wilcox that were all residences metered i ı addition to business premises, the resumption of pumping in Brooklyn would be delayed several years, during which large savings would result through the use of gravity instead of pumped water.

The cost and efficiency records may be divided into the following sections:

First. Collation of cost data, consisting of labor, material and supplies.

Second. Compilation of statistics, showing amount of pumpage, consumption of coal, etc.

Third. Computation of efficiency records, showing engine and boiler performances.

Fourth. Determination of unit costs.

The cost data for labor are collated from weekly or monthly payroll analysis sheets, the basis for which is found in the character and amount of work performed shown on each employee's time sheets. The cost of material and supplies is obtained from priced requisitions on storekeeper or vendor's invoices, which are functionalized according to use. The consumption of coal is obtained from the enginemen's daily reports. A proper functional classification of accounts for this purpose is given in the author's article "Interpretation of Water Works Accounts" as follows:

Pumping station costs

Superintendence
Operation
  Labor
  Fuel
  Packing, oil and waste
  Minor equipment
  Miscellaneous

Maintenance
Repairs and replacements
Buildings and grounds
Boiler plant
Pumping machinery
Miscellaneous equipment
Depreciation
Buildings
Boiler plant
Pumping machinery
Miscellaneous equipment
Computed burden (overhead)

TOTAL COST OF OPERATION

The compilation of statistics of pumpage, etc., is made from the enginemen's daily reports of pumping station operation made on a blank reproduced herewith. This report contains a record of the performances of each engine during the different watches. It shows the relative efficiency of the different employees on duty during the three watches. The principal facts indicated by it are:

1. Hours of operation
2. Engine counter readings
3. Actual gallons pumped
4. Lift of water—both intake and discharge
5. Hourly steam pressure
6. Hourly condenser vacuum readings
7. Temperatures of feed water and flue gas
8. Feed water meter readings
9. Coal summary
10. Boilers in service
11. Engine constant and method of determination.

The computation of efficiency records is made from the enginemen's daily reports above described on the accompanying form. The result of each day's operation is copied from the enginemen's report and entered on a separate line in columns 2 to 11, which are summarized at the end of the month. The following formulas cover the computation of efficiency data for each month.

CITY OF NEW Y

STATION No. _____

DEPARTMENT OF WATER SUPPLY,
BUREAU OF WATER

STATION _____

DAILY REPORT—PUMPI

WATCH No.	ENGINE No.	ENGINE HOURS START	ENGINE HOURS STOP	ENGINE HOURS RUN	ENGINE COUNTER READINGS START	ENGINE COUNTER READINGS STOP	ENGINE COUNTER READINGS REVOLUTIONS	TOTAL REVOLUTIONS	ENGINE CONSTANT	ACTUAL GALLONS PUMI	
1	2	3	4	5	6	7	8	9	10	11	12
1											
2											
3											
1											
2											
3											
1											
2											
3											
1											
2											
3											
1											
2											
3											
								TOTALS			

TIME	FEED WATER METER READINGS Unit	COAL FIRED—WEIGHT AND KIND—(LBS.)			WEIGHT OF ASH (LBS.)
4 a. m.					
8 a. m.					
12 (noon)					
4 p. m.					
8 p. m.					
12 p. m.					
Total					

COAL SUMMARY FOR 24 HOURS (LBS.)

	KIND OF COAL			
A	COAL ON HAND BEGINNING OF FIRST WATCH			
B	COAL RECEIVED			
C	SUM OF A AND B			
D	COAL USED FOR PUMPING			
E	COAL USED FOR BANKING			
F	TOTAL COAL USED			
G	COAL ON HAND END OF LAST WATCH			

BOILERS IN SERVICE

WATCH NO.	ENTIRE WATCH	PART OF WATCH
1		
2		
3		

NOTE:—The data relating to Engine Constant is to be entered in t
each test for Pump slip, or when for any reason the Cons

ENGINE CONSTANT For Engine No.	=	THEORETICAL DISPLACEMENT PER REVOLUTION Gallons	x	CORRECTION FACTOR FOR ACTUAL DISPLACEMENT Factor	=	Gallons
	=		x		=	
	=		x		=	
	=		x		=	
	=		x		=	
	=		x		=	
	=		x		=	

REMARKS:

NEW YORK
PLY, GAS AND ELECTRICITY
TER SUPPLY

REPORT No. _____

MPING STATIONS

DATE _____ 191__

PUMPED AND DISTRIBUTION		TIME	INTAKE HEAD. SUCTION OR PRESSURE	DISCHARGE HEAD			STEAM PRESSURE AT STATION	CONDENSER VACUUM AT ENGINE (INCHES OF MERCURY)						FEED WATER TEMP. ENTERING ECON. OR BOILER	FLUE GAS TEMP. ENTERING ECON. OR STACK
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
		1 a. m.													
		2 a. m.													
		3 a. m.													
		4 a. m.													
		5 a. m.													
		6 a. m.													
		7 a. m.													
		8 a. m.													
		9 a. m.													
		10 a. m.													
		11 a. m.													
		12 (noon)													
		1 p. m.													
		2 p. m.													
		3 p. m.													
		4 p. m.													
		5 p. m.													
		6 p. m.													
		7 p. m.													
		8 p. m.													
		9 p. m													
		10 p. m.													
		11 p. m.													
		12 p. m.													
		TOTALS													

	(a) AVERAGE DISCHARGE HEAD			
(HOURS)	(b) AVERAGE INTAKE HEAD			
	(c) TOTAL HEAD FROM GAUGES			
	(d) CORRECTION FOR HEAD			
	(e) ACTUAL PUMPING HEAD			

AVERAGES OF PRESSURES AND TEMPERATURES

STEAM PRESSURE	CONDENSER VACUUM INCHES OF MERCURY						FEED TEMP.	FLUE GAS TEMP.

ed in the table below ONLY after
he Constant is changed.

OR ENT Gallons	ENGINE CONSTANT OR ACTUAL PUMPAGE DETERMINED BY

FIRST WATCH

FROM _____ M.
TO _____ M. _____ *Engineman in Charge*

SECOND WATCH

FROM _____ M.
TO _____ M. _____ *Engineman in Charge*

THIRD WATCH

FROM _____ M.
TO _____ M. _____ *Engineman in Charge*

_____ *Engineman in Charge of Station*

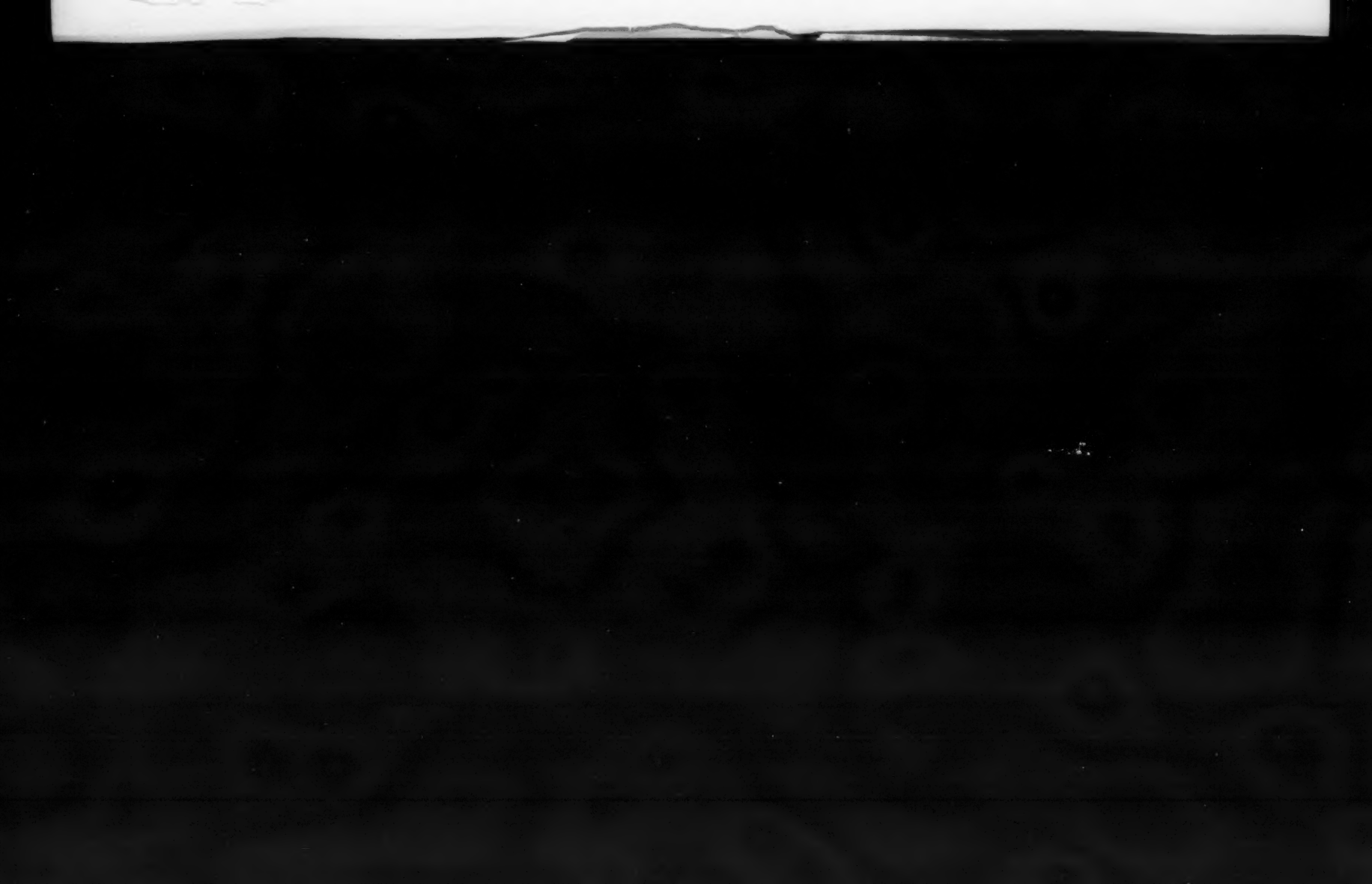

TABLE 1

Properties of steam

GAGE READINGS	THERM. READINGS	TOTAL HEAT FOR USE IN COLUMN 16	GAGE READINGS	THERM. READINGS	TOTAL HEAT FOR USE IN COLUMN 16
60	307.4	1175.7	155	368.2	1194.2
65	311.8	1177.0	160	370.5	1194.9
70	316.0	1178.3	165	372.8	1195.7
75	320.0	1179.6	170	375.1	1196.3
80	323.9	1180.7	175	377.3	1197.0
85	327.6	1181.8	180	379.5	1197.7
90	331.1	1182.9	185	381.6	1198.3
95	334.5	1184.0	190	383.7	1199.0
100	337.8	1185.0	195	385.7	1199.6
105	341.0	1185.9	200	387.7	1200.2
110	344.1	1186.9	205	389.7	1200.8
115	347.1	1187.7	210	391.8	1201.4
120	350.0	1188.7	215	393.6	1202.0
125	352.8	1189.5	220	395.3	1202.5
130	355.5	1190.4	225	397.3	1203.1
135	358.2	1191.2	235	401.0	1204.2
140	360.7	1192.0	245	404.4	1205.3
145	363.3	1192.7	255	407.8	1206.3
150	365.7	1193.5	265	411.0	1207.3

Column 12 = Col. 10 × Col. 11.
Column 13 = Col. 12 ÷ Col. 9.
Column 14 = Col. 12 × 0.0000001758
Column 15 = Col. 9 ÷ (Col. 14 × 24)
Column 16 = Take figure for "Total Heat" in Table 1 corresponding to nearest gauge pressure.
Column 17 = Col. 16 − (Col. 6–32) × (Col. 5 ÷ Col. 9) × 0.0647

That these cost and efficiency records are practical is proved by the valuable statistics which they afford the department. Inasmuch as they are kept for each station separately and in a manner that will afford ready comparison between them, such records should be adaptable to any hydraulic pumping stations. Not only do they afford a comparison between different stations, but the performance and unit cost of each station by itself can be compared independently, one period with another. The stations in Brooklyn vary in lift from 14.2 to 186 feet: in daily pumpage from 0.1 to 84.1

million gallons; in average duty from 6.7 to 60.3, and in total cost per million gallons raised 1 foot from 4.8 cents to $1.43. These varying figures will point the way for future administration of the department, so far as pumping station operation is concerned.

As the system above described is a uniform one and suited to small as well as to large works, both municipal and private, it is to be hoped that such of the numerous cities having pumping plants which do not now have similiar cost and efficiency records will adopt this or a modification of this system. Certainly, the financial benefits which have already accrued to the City of New York would seem to indicate the advisability of such a course. The need of such records has been pointed out to the private water companies operating in certain outlying districts of New York City, during the author's connection with the rate investigations and valuation of these plants. Some of the companies have already acted on this suggestion and adopted this plan of record-keeping. It is confidently expected that gratifying results will be obtained before long, and not only will these companies be furnished with data which will enable them to reduce unit costs of operation and maintenance, but the general efficiency of the employees will be increased and a consequent improvement of service result.

TROUBLES IN CONSTRUCTING A 48-INCH SUBMERGED MAIN[1]

By F. W. Cappelen

The Minneapolis distribution system required the crossing of the Mississippi River just below the Falls of St. Anthony, with a 48-inch riveted steel pipe ½ inch thick. The river at this point passes through a gorge some 900 feet between bluffs, which, on the east side of the river, reach a height of about 100 feet above low water, and on the west side, 72 feet. On the east side there are 39 feet of sand and gravel to the Trenton lime rock; on the west side, about 11 feet from the top of the ground to the lime rock, which is of the same elevation on both sides of the river. This rock is 25 feet thick and separated from the underlaying St. Peter sandstone by 3 feet of shale. The St. Peter sand rock is some 800 feet thick. The river has cut through the rock, and the river bottom is filled with broken débris of lime rock and boulders; at the deepest point about 40 feet, then the sand rock.

Eight-foot shafts were sunk on both sides of the river, and 8 by 7-foot tunnels extended from the shaft to the edges of the bluffs, 340 feet long on the east side and 60 feet long on the west side, and trenches were dug on the shores as far as possible. This work was started January 3, 1916, and completed May 27, 1916. As the current is very swift at all stages of water, it was necessary to do the river work proper in extreme low water, which occurs from the end of December to the middle of March, mostly in weather below zero. The problem was, how to excavate the trench in the material mentioned? Pile driving was impossible; the water being too swift and shallow for a dredge and no dredge is to be had on the river at this place.

It was decided to build cribs 4 feet wide and 8 feet long, made of 10 by 12-inch timbers, with partly planked bottoms, each to be loaded with about 2 tons of rock. These cribs were to be placed about 14 feet apart on centers across the river, and 16 feet on centers

[1] Read before the Richmond Convention, May 9, 1917.

up and down the stream. On these cribs across the river, 24-inch I-beams 28 feet long would be placed flatways to form a running track for the excavator, which consisted of a stiff leg derrick, with which it was expected to handle a one-half yard orange peel bucket. Before building the cribs some excavation was done with this rig on the low shore on the west side, and it seemed as if the material could be handled that way. Accordingly the placing of the cribs across the river was finished, which did not take long, and the runway completed from shore to shore. The under frame of the derrick was fitted with grooved wheels which travelled on 40–pound rails laid loose on the I beams.

The derrick was then sent back to the west end, and excavating operations continued with the orange peel bucket, but as soon as the river was reached it was found that the bucket would not work satisfactorily at all, and the rig for excavating was changed by attaching to the boom of the derrick a dipper stick, placed about 20 feet from the end of the boom, with a $\frac{3}{4}$-yard steam shovel dipper. The excavation with this machine commenced February 18, 1916, and the ditch was finished March 17, 1916. It was a very hard job. The material was exceedingly bad to handle; big pieces of ledge from earlier erosions were often encountered and they had to be dragged out. Some 2500 yards of this stuff was excavated and dumped on the downstream side. All small material was immediately washed away by the current, leaving the heavier stuff in place. As the excavation progressed towards the east side the cribs were removed. I-beams were placed on the spoil bank as a track to carry the cribs, timbers and I-beams back to the west shore. These beams also formed the pathway between the excavator and the west side.

On March 21, 1916, riveting the 48-inch pipe was commenced. The sections were all 30 feet long, and on March 26, 1916, pulling the pipe towards the east shore was commenced. The first section pulled was 120 feet long. To the end was riveted a torpedo-shaped head 6 feet 7 inches long, with heavy lugs, to which a $\frac{7}{8}$-inch plow-steel iron-center pulling cable was attached. There were also two lugs on the inside of the torpedo to which a $\frac{7}{8}$-inch plow-steel cable was attached. The pulling was done with a 25 horse-power hoisting engine and two triple sets of blocks. After this first section was pulled, 30-foot sections were added and pulled, and on March 30, 486 feet of pipe had been pulled and another day would have

landed the end on the east shore. This very day the ice broke in the upper river, about two weeks ahead of ordinary conditions; and a big ice gorge, which had formed about 15 miles above the falls, broke and a tremendous flood of water came down, in fact, about 54,000 cubic feet per second, which is very nearly the maximum flood recorded on the upper Mississippi, since 1860, when, 60,000 to 65,000 cubic feet came down. We have a low water record in December, 1910, for 1 day, with 668 cubic feet per second. The flood simply picked up the pipe and laid it downstream on the flat west shore, only shearing part of the rivets in one joint about midways. The inside cable, which was always anchored on the west shore, saved the pipe. A few days afterwards, ten million feet of logs broke away at Anoka, 18 miles from Minneapolis, and came down over the falls and cleaned out the spoil bank, I-beams and all. The beams were picked up later.

Nothing could be done now until the river went down again. In July, the pipe was taken from where the flood had left it. It was straightened, joints repaired and tested, and placed in position for handling again under low-water conditions. Meanwhile, the work of building shafts and tunnels went on, and was, as before stated, completed with the lining on May 27, 1916. The shafts were lined with concrete, and the tunnels with 6-inch vitrified tiling.

The ditch was completely filled, of course, after the flood, with sand, gravel, and smaller boulders, and it was decided that the surest and best way to excavate again would be with a drag-line excavating outfit as follows: The track cable was started from a 14 by 14-inch mast, 48 feet high set up on the east shore. The elevation of the cable hitch was about 116 feet, the west end of cable being fastened to a bridle cable subject to pull up or down stream, with a set of $\frac{3}{4}$-inch double blocks at an elevation of about 31 feet. The total span was about 980 feet. The track cable was $1\frac{1}{4}$-inch plow steel, the load line was $\frac{5}{8}$-inch plow steel, and the tension line was $\frac{3}{4}$-inch plow steel. The hoisting engine was rated at 25 horse power with steam pressure of 125 pounds. A $\frac{1}{2}$-yard bucket was used. A 20 horse power engine was placed on the west side. Setting up the cable and engine began September 11, 1916, and drag line excavation on the river proper began October 16, 1916, and was finished January 20, 1917.

The material was about as expected, but in the bottom of the trench large pieces of ledge were encountered that probably had

been shifted into place during the early stages of the flood, and it became necessary to break these large masses by dynamite before the drag could handle them.

The drag line bucket was dumped on staging placed directly over the east side trench, and the material slid down on the spoil bank made on the shore just below the pipe line.

On January 22, 1917, pulling the river sections of the pipe was begun, as before, and the pulling was finished on January 31. The last pull was about 15 feet of a total length of pipe of 698 feet. As the pipe was pulled and sections added, water was let into the pipe on the west end, so as to keep it just about afloat above the bottom of the trench. The pipe was gradually lowered into place from the west end, and closed in and riveted by February 9, 1917. On the east end, a cofferdam had to be built over the pipe, so as to make it possible to cut off the torpedo-head, put in the remaining pipe and make connections with the end of pipe at the mouth of the east tunnel. Much trouble was experienced in unwatering the coffer, as sand rock was encountered inside the dam and no puddle clay could be had with the extreme cold weather, 20° below zero all the time. However, the east end work was closed in on March 10, 1917.

As soon as the pipe had been properly placed, on February 12, the work of anchoring it started. This was done by placing very coarse fabric bags filled with sand and cement mixed 1 : 4, around the pipe, filling the entire trench in spots. Ten such anchors were placed, containing 18,000 sacks. The sand and cement were delivered on top of the west bluff. The sand was heated and mixed dry with the cement in a small mixer and the sacks filled, slid down a plank chute, wheeled to the river edge, then loaded on the drag line bucket which was fitted with a small platform large enough to hold 12 bags. The east side engine pulled the bucket out over the pipe in the river and the west side engine pulled it back. As soon as the sacks had been thrown into place, holes were punched in them by sharp pointed rods to facilitate the wetting of the contents. The cement set satisfactorily. This work was finished March 3, 1917.

On March 21, 1917, the entire work on the east side was finished, with the cofferdam removed. With everything ready, the expected flood came on April 4. The ice gorge broke about 14 miles above the falls and came very violently but without doing

any harm to the main. The river is still high and it is impossible to tell if the ditch is completely filled or not. As soon as the river recedes, it is proposed to empty the pipe and examine it for leaks, before turning on the city supply.

While it may appear that the first excavation was a total loss, the author is convinced that if the tough material had not been removed as was done the first time, it would have been absolutely impossible to do the excavation with a drag line outfit, so the loss in money and time was really comparatively small. The work was done entirely by the city's forces, as is all work in Minneapolis. The pipe was furnished by the East Jersey Pipe Company.

Mr. J. A. Jensen, Assoc.M.Am.Soc.C.E., supervisor, was in direct charge.

Detail cost of river crossing; 48-inch distribution main. Total length of crossing 1526 feet; channel portion 868 feet, tunnel and shaft portion 678 feet

	AMOUNT	COST PER FOOT OF CROSSING
Material:		
1523 feet of 48 by $\frac{1}{2}$, 48 by $\frac{7}{16}$ and 48 by $\frac{3}{8}$ inch riveted steel pipe	$16,591.85	$10.87
48 inch gate and air valves	1,537.69	1.01
Lead, cast iron pipe and specials	287.27	.19
Fittings and incidental supplies	204.55	.13
Bolts, pins, steel and iron	1,001.47	.65
Timber, blocking and lumber	2,041.64	1.33
Cement for bag anchorage and shore wall	800.16	.52
Sand for above, and for filling trench and coffer dam	647.34	.42
Burlap bags for anchorage	1,021.31	.67
Paint and coating material	66.36	.04
Cable	371.00	.24
Electric power for lights and pumping	48.77	.03
Coal for engines and shanty use	1,184.94	.77
Oil, gasoline, candles and waste	742.26	.48
Dynamite and leads	383.14	.25
Tools, rope, derrick repairs, etc	1,001.33	.65
Transporting machinery	194.55	.12
Repairs and parts	387.23	.25
Miscellaneous material	139.83	.09
Total	$28,652.69	18.77

	AMOUNT	COST PER FOOT OF CROSSING
Labor:		
Handling and dumping dredged material	$2,215.79	$1.45
Timbering and sheathing, etc	1,358.84	.89
Hauling pipe and specials	728.79	.48
Hauling supplies and equipment	3,210.90	2.10
Rigging up engines, cable ways, etc	4,062.04	2.66
Foreman and supervision	2,888.45	1.89
Building cribs, etc	1,598.21	1.05
Transporting and setting cribs	315.95	.21
Dredging with shovel	2,416.09	1.58
Dredging with drag line	4,801.61	3.15
Watchmen on engines and camp	1,473.20	.97
Boiler work on steel pipe	4,193.53	2.75
Blacksmith, tool work and repairs	1,203.61	.79
Cutting pipe	287.88	.19
Scraping, cleaning and recleaning and painting pipe	481.31	.32
Setting 48 inch gate and expansion joints	121.50	
Setting air valves	7.50	
Laying and erecting pipe in tunnel and shaft	898.68	.59
Anchoring pipe with filled bags	1,490.86	.98
Unwatering coffer dam	497.70	.33
Concreting east shore	298.05	.20
Pulling pipe into channel	691.43	.45
Moving materials	223.56	.15
Miscellaneous work	688.83	.45
Total	$36,154.31	$23.69
Total cost labor and material*	$64,807.00	$42.46

* Unit costs per foot in channel. Cement for bag anchorage and shore wall, $0.94; sand for same and for filling trench and coffer dam, $0.77; burlap bags for anchorage, $1.19; dynamite and leads, $0.45; rigging up engines, cableways, etc., $4.79; building cribs, etc., $1.88; transporting and setting cribs, $0.37; dredging with shovel, $2.84. dredging with drag line, $5.67; anchoring pipe, $2.20; unwatering coffer dam, $0.59; pulling pipe into channel, $0.82.

The cost of the pipe in the tunnel and shaft was $1.32 per foot.

Detail cost of shafts, 149.7 feet in total vertical length

	AMOUNT	COST PER VERTICAL FOOT
Material:		
Coal for hoist	$150.00	$1.00
Crushed rock for concrete	237.75	1.58
Dynamite and caps	75.00	.50
Tools, etc	125.00	.83
Cement for lining shafts	1,000.00	6.67
Use of hoisting machinery	171.45	1.15
Repairs and parts	50.00	.33
Lumber	200.00	1.34
Drilling 6 inch hole through rock for drainage	66.15	.44
Miscellaneous material	40.00	.27
Total	$2,115.35	$14.13
Labor		
Supervision and foremen	$473.91	$3.16
Watchmen on engines	1,012.20	6.76
Excavating	1,370.89	9.16
Bracing	208.75	1.39
Sheathing	91.00	.61
Bailing water	90.00	.61
Drilling	246.50	1.65
Blasting	34.25	.23
Building trestle	3.00	.02
Cribbing under shaft	5.00	.03
Concreting	286.69	1.92
Rigging up mixer	105.00	.70
Moving derrick	15.00	.10
Placing beams in shaft	76.10	.51
Back filling	102.50	.68
Hauling materials	401.36	2.68
Total	$4,522.15	$30.21
Total cost labor and material	$6,637.50	$44.33

Detail cost of tunnels, 392 feet in total length

Material:		
Crushed rock	$174.24	$.44
Dynamite and caps	75.00	.19
Wall tile for lining	724.66	1.85
Tools, etc	125.00	.32
Cement	160.30	.41

Detail cost of tunnels, 392 feet in total length—Continued

	AMOUNT	COST PER VERTICAL FOOT
Repairs	$50.00	$.13
Lumber	50.00	.13
Drain tile	42.14	.11
Power and lights	75.00	.19
Miscellaneous material	40.00	.10
Total	$1,516.34	$3.87
Labor:		
Supervision and foremen	$473.91	$1.21
Excavating	1,260.28	3.22
Drilling	104.00	.27
Blasting	84.75	.22
Bracing	229.13	.58
Laying tracks	142.20	.36
Excavating for drain tile	72.75	.19
Back filling	375.63	.96
Laying drains	69.25	.18
Excavating for lining wall foundation	90.50	.23
Lining tunnel with tile walls and arch	604.19	1.54
Concreting wall foundation	344.00	.88
Hauling materials	401.36	1.02
Total	$4,251.95	$10.84
Total cost labor and material	$5,768.29	$14.71

SEEKING BETTER INSURANCE CLASSIFICATION FOR SMALL CITIES[1]

By C. M. Roos

The problem of how to secure lower insurance rates is one with which many cities have wrestled, and in many cases unsuccessfully. It is not the intention to attempt in this discussion to give some startling solution by which any municipality can, without real effort and expense, enjoy a better insurance classification. The purpose is simply to treat the subject of fire insurance from a standpoint which will show in an unprejudiced way some of the reasons why some cities have not been more successful in securing a better insurance classification.

It is fully recognized that the fixing of insurance rates and classifications has been almost entirely in the hands of a private independent organization, which controls the situation and which, to a large degree, has dictated its own terms and policies. This fact, of having within itself almost exclusive authority to dictate its own policies in dealing with the public, has resulted in possibly an unfair advantage having been taken of some cities in some instances by the fire underwriters. A distinct prejudice against the insurance organizations has sprung up in many cities on account of this.

The state insurance organizations as well as the National Board of Fire Underwriters have made desperate attempts to stem the tide of public prejudice against them, and in doing so have worked along intelligent, scientific lines. One of the steps taken in this direction is the recent adoption of new fixed standards and rules, which eliminate very largely discrimination in classifying cities. The Standard Schedule for Grading Cities and Towns of the United States with Reference to Their Fire Defenses and Physical Conditions, adopted by the National Board of Fire Underwriters, of New York City, in 1915, is a complete, scientific work by which a city's protection against fire can be quite accurately measured in a comparative manner. No attempt is here made to defend the

[1] Read before the Illinois Section at Urbana, on March 13, 1917.

methods which have been in use in classifying cities. It is quite generally admitted by the fire insurance authorities themselves that in the past the standards in use by which to measure a city's ability to prevent and cope with fires were not uniform, and that discrimination, intentional or otherwise, was often charged and actually existed. No attempt is made here, either, to justify the insurance organizations for some of their rulings and decisions of the past.

It is desired, however, to place special emphasis upon the fact that the recently adopted national standard is a scientific work. It shows evidence of having been prepared in the best of faith and along proper lines. A study of it convinces one of the difficulty encountered in attempting to prepare a standard that will cover all cities. Local conditions are not the same in any two communities. It is necessary to have a classification schedule sufficiently flexible to permit its use in measuring any city, and yet of a character that its use in measuring a city's defense against fire will be fair, equitable and scientific. Fire insurance classification must be along scientific lines. It cannot safely be otherwise, and must not be allowed to be otherwise. Neither the insured nor the insurer can assume the risk of having it otherwise.

There is a strong tendency toward favoring local or mutual insurance organizations, which undoubtedly has resulted from some of the past methods of the fire underwriters. It is proper that a word of warning be given in this connection. No local or mutual insurance organization can afford to take fire risks that are not, to a degree, at least, scientifically figured. The fact that a certain building without fire protection has stood for thirty years without a fire loss, is no argument why any company or organization is justified in placing insurance upon it at a very low rate. The fact that a certain city with only ordinary fire protection has had a very low fire loss covering a period of a number of years, is no argument why that city should have a lower insurance rate than a similar city with similar fire protection, which has had a higher fire loss in the same period, as there is no guarantee that the future losses of th· first city will not be heavy.

Many applicants for life insurance are rejected each year by our large reliable life insurance companies on account of some physical defects on the part of the applicants. The fact that some of these rejected applicants live to be much older than some of those who passed the physical examination and secured insurance, is no argu-

ment why the life insurance companies can afford to accept all risks without examination. The mortality tables of life insurance companies are accurately figured, and it is directly due to this fact that their risks are scientifically and carefully selected. The exceptional cases cannot govern action by any insurance organizations.

There are many instances in nearly every small city where a business firm will decide upon a location for a large structure and construct it without giving the matter of fire protection any consideration whatever until the time comes to get a rate for insurance. The lack of proper fire protection in such a structure may not only have a decided effect upon the rate for the building itself, but may effect the rate in the entire block in which it is located.

The public water supply in many small cities is very often provided for without figuring in advance what results can be obtained from a fire protection standpoint. Approximately 50 per cent of the cost of the average public water-works system is directly to provide for fire protection. No such expenditure should be made without first determining what results can be obtained.

In many small cities the fire department is not efficient. It is not always due to failure to expend sufficient money to make the fire department efficient that some cities do not have in their fire departments that which the insurance authorities ask for. It is often because the money had not been used to the best advantage. High priced equipment in a fire department doesn't always spell Efficiency.

The average small city has laws governing building, wiring and other physical conditions within certain restricted limits, but in many cases these laws are either improperly framed, or, if adequate, they are not enforced. A good law covering any one of these subjects, which is not enforced, has no value whatever and cannot give the city any credit from a fire insurance standpoint.

This entire discussion thus far is a plea for recognition on the part of the smaller cities of the value and absolute necessity of recognizing scientific methods for preventing and fighting fires.

Assuming that it is generally agreed that it is proper that a scientific standard for insurance classification for all cities should be adopted, and further, that it is directly to the interest of the individual, the municipality and the insurance companies that such a standard govern in all cases, the next step is to determine whether the local community or the small city is getting its full benefit or

share of the standard adopted, and the best way to secure the maximum benefits to which it is entitled under such a standard.

What can prevent a city from enjoying what it is entitled to under a schedule which applies throughout the entire United States? Why should not any city demand and enjoy its rights under such a plan? In the first place the matter must be handled intelligently, not by inexperienced, unscientific men. Here is one of the big mistakes which have been made by small cities in dealing with this matter. Not all of the mistakes in wrestling with fire insurance problems have been made by the insurance companies. Many of them have been made by the insured themselves.

The amount of money paid out in insurance premiums in the average small city is much larger than is generally known, yet with the large amount involved in the insurance of the physical property of a community, all of which comes directly out of the pockets of the individual citizens, there has been little intelligent scientific thought given it by the insured, there has been no coöperation whatever by those who are paying the money, there has been no study of the subject, and there has been very little effort made to reduce fire risks.

There has been community coöperation along many other lines, but little if any along the line of reducing fire risks. The shippers of a community have expert traffic men, who, in addition to the salaries they receive, save thousands of dollars annually for the shippers. In almost any small city an expert on fire prevention, who would give his entire time to it, would save to the community his own salary, and in addition, a large sum in lower insurance premiums each year. But the saving would not only be reflected in the annual insurance premiums. Fire insurance cannot cover all losses to an individual or a community. The saving of property which fire insurance cannot cover, and the increased real estate values as a result of improving the appearance of the community, would more than pay such an expert's salary. Some cities are now securing the assistance of the engineers of the insurance companies in making their plans for municipal improvements, consulting them in advance that they can secure the maximum results from a fire insurance standpoint for the money to be expended.

Most cities have enough money invested in their water works and fire departments to insure the maximum fire protection at minimum insurance rates, but they are not enjoying this benefit because the

money has not been expended efficiently. It always pays to secure scientific expert advice before spending money in making improvements of this character. A building poorly designed may cost more than one designed along proper lines, and after it is constructed it is difficult and expensive to correct the errors and get desired results. Several cases are known where large structures were being planned and expert advice on how to secure maximum fire protection for the buildings, at very little additional first cost, was offered gratis for the good of the community, and the matter was not considered of sufficient importance to accept the offer.

The best results can be obtained by small cities in securing the best classification possible for fire insurance by working together in sections or states. All cities under a certain size should be represented by committees or individuals who have made a study of the insurance problem, at conferences or conventions called at certain intervals, where a thorough, practical study can be made of the standards set up by the underwriters, and also to what extent such standards can be applied to the several communities represented. These studies should be scientific. Such a plan would unquestionably result in small cities securing a clearer conception of what fire prevention and protection really mean, in qualifying them to adopt proper city laws to control fire risks, and to get the maximum results for every dollar expended for equipment for water-works and fire departments. Such a plan would also enable small cities to coöperate with the insurance organizations, and to demand the classification to which they are entitled. No small city would be left to fight its insurance troubles alone, without being properly equipped to discuss the subject intelligently. Work along these lines would correct many errors now existing, and would prevent many errors which are continually being made by municipalities in providing for fire protection.

Combine the amount of money expended each year by cities in Illinois with less than 25,000 population, in maintaining fire departments and in paying fire insurance premiums, and we have a total that staggers us. There is probably no other enterprise in the state involving the actual expenditure of such a vast sum of money each year that is handled so carelessly or indifferently. Here is a hint to some of our cities as to where a saving can be made in the annual city expenses.

THE ECONOMY OF METERS[1]

By C. L. Köhn

The sale of water is a vital question to every municipality, for the reason that if not properly and fairly sold it becomes a liability to the vendor, be it a private or municipally owned plant. On the other hand, it may become one of the city's greatest assets, if properly sold.

The sale of water under the flat rate system is unfair to both the producer and consumer. One consumer is conscientious and uses water judiciously, taking care not to let it run unnecessarily, and attending to leaks which, though small, amount in the aggregate to much. The other type of consumer wastes water by letting it run night and day, sometimes to avoid freezing, at other times for refrigerating purposes; who sprinkles his lawn and garden without a nozzle on the hose; and who is careless in every respect, knowing that no matter what amount he uses his bill will not be any larger than that of his economical neighbor, and knowing, too, that the city has absolutely no check upon the amount he uses.

The waste of water is generally practiced during hot weather and dry spells, when it is essential to husband the supply without crippling the consumer. This waste has a serious effect upon the supply, often necessitating the installation of more wells, machinery and equipment at great expense, which results in a high cost of maintenance and no larger revenue. On the other hand, in a system which is metered, these conditions are changed. To change the system, however, proper ordinances must be passed. The cost of installation is an item of considerable expense, but the expenditure is a good investment, as will be shown by comparison later.

Service and not revenue should be uppermost in the minds of the management of a municipal plant. The meter system ought to be and generally is satisfactory to a consumer, and when satisfaction to both consumer and producer is established, the results can but spell success.

[1] Read before the Illinois Section at Urbana on March 13, 1917.

The city of Elgin owns all meters except those owned by consumers using more than 10,000 cubic feet per quarter. The only cost to the consumer is to have the plumbing prepared for the installation of the meter, the department seeing to it that meters are so placed that freezing is reduced to the minimum. When the meter is installed, the waste of water soon ceases, as a large bill will remind the consumer of the necessity of calling a plumber to rectify conditions; while if the consumer be of a careless type he pays for his own carelessness and the city loses nothing.

Plumbing inspection is another essential factor. The department of plumbing inspection is connected with the water department, and no work of any kind can be done by the plumber without first obtaining a permit from the office. After the work is completed it is inspected, for which inspection the department receives a fee of $2. This insures the householder a first-class sanitary job according to the city ordinance. The water department also makes all repairs on meters, for which work the consumer is charged only the actual cost. Under no circumstances are plumbers allowed to install or repair meters, for it would then be impossible for the department to keep a proper check upon the work. The repair department is complete in every respect, and the cost of maintenance of meters is practically nothing.

For reading meters, the city is divided into three districts, the meters in each district being read every quarter. The results are most satisfactory and economical to the department for the following reasons:

First; A certain amount of revenue is received monthly with which to do business, enabling the department to take advantage of discounts in the purchase of material and supplies.

Second; The office force is materially reduced as well as the number of meter readers. The readers of meters alternate, in no case reading the same meter during two consecutive quarters, thus avoiding carelessness and errors.

The city commenced installing meters in 1902. At the end of the year there were 3263 consumers, and of these 210 were metered. The pumpage for the year was 725,000,000 gallons, the revenue being $30,013.68.

In 1910 the city had 4655 consumers, of whom 2728 were metered. The pumpage for the year was 787,000,000 gallons and the revenue $53,687.63.

In 1915 the city had 5226 consumers, of whom 5200 were metered practically 99 per cent. For various reasons 26 consumers could not be metered. The pumpage for this year was 413,360,580 gallons, the revenue $54,223.88, showing an increase in revenue of $14,210.20 over the year 1902, and a decrease of 311,639,420 gallons in pumpage, notwithstanding the fact that the number of consumers in 1902 was 3263 as against 5226 in 1915, or a difference of 1963 consumers.

There is absolutely no free water. The city meters all public buildings, the city hall, schools, library, fire barns, parks, and also all public drinking fountains.

The large manufacturer and the railroads pay the same amount as the small householder for the same amount of water.

The rate is a sliding scale as follows:

For first 166 cu. ft. or under, per 666 cu. ft.	$1.25
For each 100 cu. ft. in excess of 666 cu. ft. up to 3,333 cu ft.	.15
For each 100 cu. ft. in excess of 3,333 cu. ft. up to 10,000 cu. ft.	.115
For each 100 cu. ft. in excess of 10,000 cu. ft. up to 26,666 cu. ft.	.075
For each 100 cu. ft. in excess of 26,666 cu. ft.	.0525

The minimum amount is $5 per annum, and if, at the end of the year, less than $5 worth of water has been used, the difference sufficient to make up $5 for the year is then paid. The small consumer, realizing that he might better use the balance of the $5 worth of water rather than pay for any amount not used, generally uses it during the summer on his lawn and garden.

The water department of the city is absolutely self-sustaining, retiring all bonded indebtedness, making all betterments, as well as installing all mains, etc., from its earnings, and has been able in addition to use part of its earnings to equip the fire department with motor-driven apparatus and still have a balance for the sinking fund. This showing is attributed to the economy of meters.

DISCUSSION

R. C. MARSH: The author states that the cost of repairing meters has been practically nothing. This may have been due to the absence of any comprehensive, systematic testing, which would show what meters were running slow or had become stuck.

W. J. SPAULDING: In Springfield the experience with meters has been similar to that in Elgin, although the reduction in pumpage is not so great. The speaker cannot agree with the author's statement that the cost of maintaining meters is so small as to be of very little importance. The department at Springfield has a system of reporting the cost of every repair job. For the year just passed the expense for repairs amounted to nearly $2000, including both labor and material. As there are in service about 10,000 meters, this would mean an average cost of 20 cents per meter per year for maintenance. In addition to this cost, the cost of meter reading will amount to about as much more.

VALUE OF LABORATORY CONTROL OF OPERATION OF WATER PURIFICATION PLANTS[1]

W. W. DeBerard: Samples taken from twelve different points over the system of the Denver Union Water Company last November and analyzed in four different laboratories indicated a remarkable uniformity of result, considering the fact that each laboratory used its own particular routine. This routine was essentially the same throughout except for the medium used in the fermentation tubes for the B. coli tests. One used lactose bile; another, fresh ox bile; another, "bacto-bile" and the fourth, dried ox gall. The laboratories collaborating were those of William C. Mitchell, city bacteriologist, Denver; Dr. John B. Ekeley, state chemist, University of Colorado, Boulder; H. I. DeBerard, chemist, Denver Union Water Company, and Prof. W. G. Sackett, bacteriologist, Colorado Experiment Station, Ft. Collins.

Some of the figures are as follows: From the infiltration galleries at Mississippi Street the average of five counts on gelatin at 20°C., after forty-eight hours was 11, with a maximum of 16 and minimum of 6. Raw samples taken from Marston Lake averaged 520, with a maximum and a minimum of 750 and 300 respectively. Similar figures for the effluent of the Platte Cañon slow sand filters, treated, were 49, 75 and 12. A mixed supply taken from the tap in the city chemical laboratory gave an average of 42, maximum of 69 and minimum of 21.

Typical results on agar at 37°C. for the Platte River, raw, are as follows: Average, 52; maximum, 73 and minimum, 17. For the Willard rapid filter effluent, treated, the average was 3, maximum 5, and minimum 2. From a drinking fountain at the corner of First Avenue and Broadway the average was 8, maximum 17 and minimum 3.

Equally close uniformity extended to the samples examined for B. coli per 100 cc. From the Mississippi Street galleries, Marston Lake treated, a slow sand filter effluent at Wynetka, Platte Cañon

[1]A discussion at a meeting of the Illinois Section at Urbana on March 13, 1917.

infiltration galleries, Willard rapid filters, a drinking fountain and the Cherry Creek infiltration galleries, no coli were found by the analysts.

O. M. SMITH: Laboratories in small plants are often placed in unoccupied corners somewhere in the filter or boiler room. Here they are neglected and gradually become an eyesore instead of an inspiration to the superintendent and the workman. The tendency of recent years has been to place more importance on the laboratory. Superintendents are finding that a well equipped and well appearing laboratory is quite an asset and a valuable advertising feature to the plant. The speaker understands that the American Water Works & Electric Company finds the attractive, clean and modern laboratory a paying investment and that it is its intention while rebuilding the plant at East St. Louis, Ill., to install one of the finest plant laboratories in Illinois. If the laboratory is kept clean, polished and has on exhibition interesting data and specimens, such as graphs of turbidity, number of typhoid cases, efficiencies, plates of bacteria, samples of water and sections of filters, visitors and the public will become vitally interested in what the company or department is endeavoring to do. An interested and sympathetic public is one of the company's best assets.

On the question of records, the speaker has found that if data such as pumpage, fuel duty, turbidity, coagulant, bacteria counts, efficiencies, cost, etc., are daily plotted on cross-section paper in such a manner as to be easily understood, the employes will become more interested in what they are doing and more in sympathy with the economical and efficient methods.

W. R. GELSTON: It is obvious that some systematic laboratory control should be applied to every water purification plant. The fact that a purification plant is necessary to make the water satisfactory is good evidence that the untreated supply is more or less turbid, colored, and polluted. The purification of a water supply adds very materially to the final cost to the department of delivering it to the consumer. We hear much in this enlightened age of "Safety First" and "Efficiency." "Safety First" applied to purification plant operation should mean that the primary object of the purification plant is to produce at all times an effluent safe for human consumption. "Efficiency" applied to plant operation means

economy. The man responsible for the operation of a water purification plant should adopt a motto something like this: "Strive for the best efficiency consistent with safety first."

Without laboratory control, the operator cannot be certain that he is reducing his coagulant and sterilizing cost to the minimum consistent with safety of effluent. Neither can he limit his laboratory control to a mere determination of the alkalinity, color, and turbidity of his raw water and effluent. He must apply bacterial control to determine whether the effluent is safe for human consumption or not.

At Quincy, alkalinity and turbidity determinations were begun many years ago. Bacterial control dates from 1909, when G. A. Van Brunt was sent to Quincy by the State Water Survey to install apparatus for bacterial tests and to instruct water works employees in the standard methods applied to such tests. A small laboratory was fitted up in one corner of the pumping station. Media were purchased from the State Water Survey. About five samples each of river, settled and filtered water were plated each week. This limited control soon demonstrated the need of extensive improvements. The improvements were not secured at once, but municipal history does not reveal many instances of locking the stable door before the horse is stolen.

A new purification plant was completed in August, 1914. A new intake pipe was completed a year later, and a liquid chlorine machine was installed early in 1916. Quincy now secures its water supply from a point in the Mississippi River which is not subject to pollution by sewage. The water is coagulated, settled, filtered and finally sterilized. That "Safety First" has been secured is evident from the mortuary records kept by the board of health. During 1916 there were two deaths from typhoid fever reported in Quincy. One was a case imported from Camp Point for treatment in a local hospital. The other was a young man who lived in a house not supplied with city water. Quincy has a population of about 38,000. Two deaths per year are, therefore, equivalent to 5.3 per 100,000. The lowest previous record for Quincy was seven deaths per year, or 19 per 100,000, and most of those deaths were probably due to an unsafe water supply.

Since safety is now secured it might be suggested that bacterial control is unnecessary or that the extent of such control might properly be curtailed. Nevertheless, it has been kept up regu-

larly. Just how it has been kept up may be of intere t. The speaker has always collected the samples, plated them, made the counts, and recorded the results. Since the new filter plant was erected he has also prepared all of the media used in the work. The filter man has been pressed into service to make the alkalinity, color and turbidity tests, and he also washes and sterilizes the glassware and assists in the preparation of the media. It requires about three and one-half hours of the speaker's time to prepare a 2-liter batch of agar which will last about five weeks, and about three hours to prepare sufficient lactose broth to last five weeks. It requires an average of about one and one-half hours to collect samples, plate them, make the counts, and record them. Samples are collected and plated about twenty times each month. Five different samples of water are collected for each plating and duplicate agar plates are run on each sample.

The filter man might be allowed to do all of this work, but the laboratory control supplies the only reliable check upon the filter man. The results of the bacterial tests, especially, show whether he has been faithful in the performance of his duty or not. Therefore, the speaker has always preferred to attend to the bacterial work himself.

It is now generally known throughout the city that the superintendent of the water department makes regular bacterial tests of the water and the consumers realize that everything possible is being done to insure a safe supply. He is sometimes called upon to test samples of water from private wells and cisterns. Such tests are always made without charge. Expert bacteriologists might possibly condemn this practice, but recently it was made to produce three water services where only one grew before. It happened in this way. A lady telephoned to inquire whether she could have a cistern water tested. She stated that she had been getting her water from a yard hydrant two doors away, but this hydrant was frozen up and she did not want to use the cistern water at her house until she knew that it was safe to drink it. The test was made and it was found that one man owned three cottages, all of them occupied by tenants. He laid a water service for one house and paid a flat rate for water for one house only. He then instructed the tenants in the other two houses to get water from the hydrant at the first house if they preferred the city water to cistern water. They preferred the city water and the landlord now pays for water for three houses where he paid for only one before.

L. A. FRITZE: The value of the laboratory in connection with the operation of water purification plants can best be judged by the results that are being obtained. The results firmly establish the fact that every filtration plant, even to the smallest, requires a laboratory to maintain an intelligent idea of the quality of the effluent produced. In the smaller plants, where the design and construction, as a rule, are less perfect, it is quite important that routine laboratory tests be made in order to obtain a satisfactory degree of purification. The tests required are simple and in these small plants a man with average intelligence can be trained to handle this work in a very satisfactory manner. In the plants, however, where it is possible to employ a chemist the operation will be placed upon a better basis and the proper solutions of the many little problems that arise will have a marked influence on conditions at the plant.

Aside from the daily routine analyses to determine the quality of the raw and filtered water and the work required to maintain the filters and other equipment in a satisfactory condition, there are other things in which the laboraory can prove its value. In the purchase of coal, chemicals and the large variety of material used by a water department the laboratory can be of the utmost importance. The handling of bad water complaints is another duty. Sediment or color, odor or taste will produce their share of objectors and if these consumers be referred to the laboratory for enlightenment, a non-technical explanation in a courteous manner will do a great deal towards making the chronic kicker and others good friends of the department.

In the municipally owned plants it is possible for the scope of the work of the laboratory to be enlarged to include a number of things. With the work of the water department properly systematized valuable assistance can be given to other departments of the city. The work of the health department requires the same care as that of the water department. Establishing and maintaining the standards of purity for the milk supply, ice cream and the various foods sold on the open market present problems only to be solved by the laboratory. Making examinations of sputum, diphtheria cultures, urine and other work, valuable to the physicians, will render the laboratory a valuable addition to the city. The street department can be aided by tests of the various materials used, and, in fact, everything purchased by the city, where an analysis is of use in determining value, the laboratory is a help.

A number of cities allow the matter of expense to stand in the way of having a municipal laboratory. When the work accomplished by a laboratory in a year's time is summed up, it is quite apparent that the financial saving exceeds the expense and the health work combined with the laboratory-control work for the filtration plant have cost the city very little. In this connection the speaker wishes to say that the valuable work carried on by the State Water Survey in checking the water supplies of the state and encouraging cities to establish municipal laboratories should be heartily endorsed.

REPORT OF THE COMMITTEE ON WATER CONSUMPTION[1]

This committee was continued mainly for the purpose of securing by coöperation with the New England Water Works Association, a form for water consumption statistics that would be adopted by both associations. The New England Water Works Association signified its willingness to aid in the accomplishment of this purpose by appointing on the following conference committee: C. M. Saville, P. R. Sanders, E. W. Kent, D. A. Heffernan, E. S. Cole.

Joint meetings have been held, and various members of the committee have presented their views in writing. Your committee submits for consideration two forms to be used in the collection and publication of water consumption statistics. These forms are described as follows:

Form "A," to be used when only water consumption statistics and those closely allied thereto are to be presented.

Form "B," to be used when incorporated in a report, based on the form adopted by the American Water Works Association in 1908.

These forms are attached hereto. The forms have been made as simple as possible, and consistent with the presentation of information which it is believed will generally be considered useful by the water supply profession.

Your committee has been impressed by the dearth of water consumption statistics which are comparable and typical of the various sections of this country. It believes that this association would be rendering a service that the membership generally would appreciate if the association should publish yearly the consumption statistics of typical communities in the various sections of our country. The communities should be selected so that the statistics of a fully metered community would be placed in comparison with those of a community in which only a small fraction of the supply is metered. By selecting say, from 50 to 100 of such communities and enlisting their aid in furnishing accurate statistics, information of great and increasing importance would be made available. Each five years, beginning with the year 1920, statistics should be pub-

[1] Presented at the Richmond Convention, May 11, 1917.

lished, setting forth the more important water consumption figures for a much larger number of communities, selecting these communities so that a reasonable percentage of each size would be recorded. It is suggested that this list include all cities having a population of over 500,000, 50 per cent of those having a population of from 250,000 to 500,000, 25 per cent of those having a population from 100,000 to 250,000, and 10 communities between each of the following limits:

50,000 to 100,000
25,000 to 50,000
10,000 to 25,000
Under 10,000

By coöperation with the New England Water Works Association, the labor and expense of collecting and publishing this information can be divided between the two associations and the information furnished to the combined membership.

Your committee makes the following recommendations:

First. That form "A" be adopted for use where water consumption statistics only are to be recorded.

Second. That a committee on uniform annual reports be appointed, the membership to represent those interested in pumping, filtration, water consumption, distribution, services, meters and financial questions; that the New England Water Works Association be requested to appoint a similar committee; that these committees, if possible, agree on a statistical form which will cover the entire water works field; that the committee of this association report at the next annual meeting the form recommended; and that this committee also report to what extent the association should collect and report statistics, giving the names of the communities from which such statistics should be regularly obtained and published.

Third. That your present committee should be finally discharged.

EDWARD S. COLE, *Chairman.*
WM. W. BRUSH,
J. N. CHESTER,
JOHN W. DUNLAP,
J. H. PURDY.

FORM "A."

(To be used when only water consumption statistics and those closely allied thereto are to be presented.)

1 City or town.....
2 Year for which report is made.....
3 Municipal or private.....
4 Miles of mains?.....
5 Range of domestic pressure. Is fire pressure raised? What is fire pressure?.....
6 Population:
(a) Total..... { Last U. S. Census .....
Estimated total population this date.....
(b) Supplied..... { Estimated total population supplied, using 5 per family .....
7 Total number of services in use.....
8 Total number of metered services.....
9 Per cent of metered services (8 divided by 7).....
10 How is the total water consumption determined:
(a) By meter upon supply main?.....(Yes or no)
(b) By plunger displacement?.....(Yes or no)
Slip allowed.....%
(c) Other methods—describe.....
11 Total annual water supplied for domestic uses by metered services.....
Total annual water supplied for commercial use by metered services.....
Total annual water supplied for Industrial uses by metered services.....
Total annual water supplied for public uses by metered services.....
Total metered use?.....
Estimated public use unmetered?.....
Total accounted for?.....
Total annual amount of water supplied, gallons daily?.....
Total unaccounted for?.....
Per cent total supply?.....
12 Minimum night rate (1 a.m. to 4 a.m.).....
State how this rate is obtained.....
12a Maximum rate (a) without fire.....
(b) With fire.....per hour.....per day.....per month.....
12b Total metered use per capita, daily?.....
13 Average supply per tap per day, gallons?.....
14 Average supply per day per capita, based on..... { Total population .....
Population supplied.....
15 Estimated total daily supply obtained by manufacturing or other plants from sources other than the city supply?.....

16 Total per capita daily use, including all supplies?.....
17 Cost of supplying water per million gallons, figured on total operating and maintenance?.....
18 Total cost of supplying water per million gallons figured upon total operating and maintenance, depreciation and interest upon the fair value of the plant?.....
19 Revenue per million gallons.....
Commercial. Stores, office building, hotels, boarding houses and similar establishments.....
Industrial. Railroads, factories, public gas and electric plants.....
Public. All water for public use or paid for from taxation.....

FORM "B."

(To be used when incorporated in a report, based on the form adopted by the Association in 1908)

1 How is the total water consumption determined:
(a) By meter upon supply main?.....(Yes or no)
(b) By plunger displacement?.....(Yes or no).
Slip allowed.....per cent.
(c) Other methods—Describe.....
2 Total annual water supplied for domestic uses by metered services.....
Total annual water supplied for commercial use by metered services.....
Total annual water supplied for industrial uses by metered services.....
Total annual water supplied for public uses by metered services.....
Total metered use?.....
Estimated public use unmetered?.....
Total accounted for?.....
Total annual amount of water supplied, gallons daily?.....
Total unaccounted for?.....
Per cent total supply?.....
3 Minimum night rate (1 a.m. to 4 a.m.).....
State how this rate is obtained.....
3a Maximum rate { (a) without fire..... (b) with fire.....per hour.....per day.....per month..... }
3b Total metered use per capita, daily?.....
4 Average supply per tap per day, gallons?.....
5 Average supply per day per capita, based on..... { Total population ..... Population supplied..... }
6 Estimated total daily supply obtained by manufacturing or other plants from sources other than the city supply?.....
7 Total per capita daily use, including all supplies?.....

Commercial. Stores, office building, hotels, boarding houses and similar establishments.....

Industrial. Railroads, factories, public gas and electric plants.....

Public. All water for public use or paid for by taxation.....

REPORT OF THE COMMITTEE ON PREVENTION OF STREAM AND LAKE POLLUTION[1]

The Committee on Prevention of Stream and Lake Pollution presents this as its final report.

In giving consideration to the question of prevention of stream and lake pollution, your Committee has construed its scope in this field as confined to streams and lakes which necessarily are utilized as the source of water supply for municipalities, and solely to such waterways as may receive pollution above the water supply intakes of the municipalities affected.

The primary object sought in the original appointment of this committee was the creation, by either inter-state or national governmental action, of some controlling power which would have supervision over unnecessary pollution of streams and lakes, the waters of which were required for municipal supplies, and to be endowed with the necessary power to enforce such just and reasonable regulations as would tend towards the preservation of the pristine purity of such waters. It was realized at the outset that as many of the waterways were inter-state, and even international, no comprehensive action could be secured by separate state laws unless a general coöperative spirit were inspired which would recognize either a joint control, or the adoption of a harmonious code of laws and regulations embodying an altruistic conception of the mutual benefits to be derived by all of the affected interests.

Since the original appointment of the committee, a certain measure of this ideal spirit has evinced a tendency towards realization, and conditions have gradually developed which have been productive of much greater unity of action along the lines of preventive pollution, through the broad influence of the United States Public Health Service, the International Boundary Commission, the American Public Health Association, and the many State health boards which are rapidly broadening their scope of action along scientific lines to a point that eventually will preclude the necessity for any drastic inter-state action.

The Committee on Sanitary Control of Waterways of the American Public Health Association has made some exhaustive studies

[1] Presented at the Richmond convention, May 11, 1917.

of waterway sanitation and the problems of waterway pollution, the tenor of which was published in Vol. 4, 1914, of the *American Journal of Public Health*. A later report of the same committee presented in October, 1916, dealing somewhat more comprehensively with the subject at issue, was submitted "as an endeavor to state principles and practice in the light of present knowledge" of certain phases of the art of sewage treatment and waterways sanitation. As this report has recently been published in full in the *American Journal of Public Health*, there would appear to be no valid reason for quoting at large from it, but we deem it pertinent to give herein the six basic principles laid down by said committee as a "code of regulations for the sanitary control of waterways":

1. There shall be no objectionable deposits at any point in a waterway as a result of sewage or other waste discharges therein.
2. There shall be no local nuisance created at or in the vicinity of any sewage or industrial wastes outfall, arising from excessive turbidity or the production of odors.
3. There shall be no general nuisance created in a waterway due to excessive turbidity or to odors, as a result of sewage or other wastes discharged therein.
4. There shall be no interference with, or undue burden upon, mechanical operation or bacterial efficiency of water purification plants procuring their water from a waterway.
5. There shall be no active (potentially dangerous) bacterial contamination or gross pollution of properly located and authorized shellfish beds.
6. There shall be no active (potentially dangerous) bacterial contamination or gross pollution of properly located and authorized bathing beaches and other bathing places.

Of the six articles of the code quoted above, only the first four would seem to come within the scope of what your committee considers its legitimate premises, although all are equally important from the broad sanitary view point.

In the light of conditions previously cited, and in view of the fact that the Committee on Sanitary Control of the American Public Health Association is handling the subject so comprehensively, it would appear to be a waste of effort and energy for the American Water Works Association to attempt to duplicate this work, and furthermore it would be futile for your committee to indulge in the task of writing a voluminous report which would of necessity follow along parallel lines to the report quoted. For the same reason your committee submits this as its final report, with the suggestion that the committee be relieved from further duties.

Assuming the prerogative of an advisory body, we desire to emphasize the point that it is a serious fallacy to entertain the belief that any degree of sewage treatment will eliminate the necessity for a water purification plant, if the water supply receives the sewage effluent, but it also is an indisputable fact that the final resultant of the water purification plant will be improved to some extent, at least, in a varying proportion to the degree of efficiency obtained in the sewage treatment, whether the records show it or not.

Summed up in one broad statement, the committee recommends that in every instance where conditions make such action reasonably necessary and economically feasible, all sewage should be adequately treated before being turned into any waterway which may be utilized as a source of municipal water supply within the area affected by such pollution, but that in every individual case, local and general economic conditions should govern the decision as to whether it is more advantageous to prevent or minimize the existing pollution, or whether the location of the intake or source of supply should be changed to a point beyond danger from the polluted area.

THEODORE A. LEISEN,
M. N. BAKER.

REPORTS OF THE COMMITTEE ON ELECTROLYSIS[1]

MAJORITY REPORT

Your Committee on Electrolysis begs leave to submit the following report:

At the last convention of the Association your Committee on Electrolysis submitted a report which consisted of brief statements of fact and of the stand which the committee believed the Association may properly take in regard to the electrolysis situation. This report was received by the Association, ordered printed in the minutes, and the committee was continued for further consideration of the subject. As a result of further study of this subject during the past year, your committee has somewhat modified statement 5 relating to the application of mitigating methods to underground water pipes for the purpose of making this statement more exact, and has added a clause in the last sentence of statement 6, for the purpose of more clearly stating the opinion of the committee with reference to the use of metallic connections from underground water pipes to the railway return circuit. With these two modifications your committee begs in the following to repeat the statements presented in the previous report, and hopes that the Association may find itself in agreement with these statements and will approve the report.

1. An increasing amount of damage from stray electric currents is occurring on the underground water piping systems in many localities throughout the country where adequate measures have not been taken to reduce this damage.

2. The principal and generally the sole sources of stray electric currents causing this damage are single-trolley direct-current electric railways employing the running tracks in contact with earth as part of the return circuit.

3. Inasmuch as such electric railways are the chief and generally the sole sources of stray currents causing the damage, and as the owners of such railways have no right to so operate their railway systems as to cause serious damage to the property of others, it is the duty of the owners of these railways to provide measures for reducing this trouble by removing its cause as far as this is practicable.

[1] Presented at the Richmond convention, May 10, 1917.

4. Experience extending over many years in foreign countries and over ten years in this country has shown that methods which are practicable and economical can be applied to electric railway systems which will remove acute dangers from stray currents and which will very greatly reduce the danger in all cases where bad electrolysis conditions exist, and in most cases will reduce this danger to negligible amounts.

5. Your committee believes that mitigating methods applied to underground water pipes fail to attack the real cause of the trouble. Your committee further believes that mitigating methods should be applied to underground pipes, if at all, only in special cases and only after adequate methods of minimizing the production of stray currents have been applied to the railway system.

6. Your committee disapproves as not only inadequate but frequently also as dangerous such metallic connections from underground water pipes to the railway return circuit as cause these pipes to become a substantial part of the railway return circuit. Such connections greatly increase current flow on pipes, and while they may afford local protection they generally distribute electrolysis troubles to other localities where these are more difficult to find, and thus frequently give a false impression of immunity. Your committee therefore believes that metallic connections from water pipes to the railway return circuit should generally not be permitted and in no case unless a careful study of conditions has shown that no serious danger will be produced. Such connections should in the opinion of your committee never be applied to an underground piping system as the principal means for electrolysis mitigation.

7. Your committee believes in view of the fact that the railway companies in common with the pipe owning companies are public utilities operating under public franchises and utilizing city streets, that it is the duty of both of these utilities to coöperate in order that the causes and extent of any danger from stray current can be more readily ascertained and the problem can be attacked along broad engineering lines.

Respectfully submitted,

ALBERT F. GANZ, *Chairman.*
DANIEL D. JACKSON
ROBERT H. JACKSON
EDWARD E. MINOR

MINORITY REPORT

At the twentieth annual meeting of this Association held at Richmond, Virginia, May 15 to 18, 1900, a special committee including Dabney H. Maury, George H. Benzenberg and J. Waldo Smith, reported on the question of electrolysis. The report was published in the *Proceedings* of 1900, pages 180–182. Action on this report was deferred in order that the Association's membership should have abundant opportunity to study the recommendations made in the report, which was printed and distributed. It was afterwards adopted at the Twenty-first Annual Meeting, held in New York City, June 17 to 21, 1901. The report was again published in the *Proceedings* of 1901, pages 76–79, and the Association confirmed its adoption for fourteen consecutive years.

The statements of fact contained in the original report are as true to-day as they were then. It is still true that pipe-owners cannot protect their property from damage caused by stray electric currents. It is still true that methods are known whereby operators of electric railways can control the currents used by them. Therefore, the following is respectfully submitted for your approval as expressing the attitude of this Association.

WHEREAS: Damage to underground pipe systems caused by electric currents generated and used by electric railway companies continues; therefore, be it

Resolved, by the American Water Works Association, that electric railways should control all current generated or used by them so that it will not flow upon the water mains and service pipes connected to or belonging to the water works system of cities, and this should be done by the electric railways at their own cost.

CHARLES R. HENDERSON.

REPORT OF COMMITTEE ON REVISION OF STANDARD SPECIFICATIONS FOR CAST IRON WATER PIPE AND SPECIAL CASTINGS

The Committee on Revision of Standard Specifications for Cast Iron Water Pipes and Special Castings begs to submit the following report:

Appointed in 1911, this committee has for several years coöperated with a similar committee of the New England Water Works Association.

In January, 1916, at a joint meeting, held in New York City, a Joint Committee of six members—three from the committees of each Association—was appointed to prepare a tentative draft of revised specifications, to be submitted to the manufacturers for their examination and criticism. The resulting draft was forwarded to the manufacturers on May 6, 1916, accompanied by the following letter:

To the Manufacturers of Cast Iron Pipe:

The enclosed specifications for Cast Iron Water Pipe and Fittings, prepared by a joint committee formed from the committees of the American and New England Water Works Associations, is a preliminary draft of proposed new Standard Specifications, and is sent you for your criticism and discussion.

It is the intention of the joint committee to hold a meeting in New York City within a few months, and to invite manufacturers to appear and present in person their discussion of the enclosed specifications, or if attendance is not possible, to submit such discussion in writing at this meeting, notice of the time of which will be given thirty days in advance of the date finally chosen.

For your information, a brief statement of the development of the specifications now sent you may be of interest. In June, 1911, the American Water Works Association appointed a committee to revise the existing Standard Specifications for Cast Iron Pipe, and in March, 1912, the New England Water Works Association appointed a committee for a similar purpose. Both committees at once appreciated the fact that the first object in the work should be the development of a single specification, acceptable to both associations, and which, it might be hoped, would later be adopted by all other societies and therefore become, in fact, a standard specification.

While many independent meetings of the two committees have been held during the past three years, much of the time of each committee has been

spent in considering suggestions and questions submitted by the other, and January 21, 1916, a joint meeting of the committees was held in New York City, an entire day being devoted to the discussion of the modifications and revision of a tentative specification which the two committees had been considering for a number of months past. At this meeting, it was voted that a joint committee, of six members—three from the committee of each Association—prepare a tentative draft of specifications to be sent to manufacturers for their discussion and criticism, and the specification now forwarded to you is the result of the work of this joint committee.

In submitting this draft of specifications for your examination, it may further be well to state that the committee recognize that the proposed specifications will involve some increase in the cost of production, but it is believed that the resulting advantages to users will be sufficient to make the slight increase in cost of no practical moment. It is therefore hoped that the manufacturers will approach the consideration of these specifications on the assumption that there is a substantial demand for a uniform outside diameter, and good reasons for a specification of the chemical character of the metal, for the relation between flexure and breaking load, and for an improved coating.

It is to be understood, however, that the present draft is altogether tentative, that the minds of the committee are open, and that this draft is now sent you for your discussion and criticism, with the hope that finally a standard specification may be developed, acceptable throughout this continent, at least, to the users and to the manufacturers of the pipe, and which will become effective at such time in the future as will reasonably allow for any necessary changes in foundry equipment.

JOINT COMMITTEE.

JOHN H. GREGORY,
N. F. S. RUSSELL,
WALTER WOOD.
Am. W. W. Assoc.

FRANK A. McINNES,
FRANK A. BARBOUR,
W. R. CONARD.
N. E. W. W. Assoc.

May 7, 1916.

On November 23, 1916 an invitation was sent to the manufacturers to meet the Joint Committee in New York on December 14, 1916, of which the following is a copy:

DEAR SIRS: In May, 1916, a copy of a Tentative Draft of Standard Specifications for Cast Iron Pipe and Fittings, proposed by the Joint Committee of the American and New England Water Works Associations was sent you for your examination and criticism. In the accompanying letter it was stated that a meeting, to be held in New York City, would be called at some future date, which it was hoped you would attend and present to the committee your views regarding the proposed specifications.

We now beg to advise you that this meeting will be held in the House of the American Society of Civil Engineers, No. 220 West 57th Street, New York

City, at ten o'clock a.m. on Thursday, December 14, 1916, and we earnestly desire that you arrange to attend and be prepared to discuss the proposed specification.

The draft already sent you is altogether tentative and any amendments or suggestions you may care to make will be given due consideration.

Yours truly,

FRANK A. MCINNES, *Chairman,*
New England Water Works
Assoc. *Committee.*

JOHN H. GREGORY, *Chairman,*
American Water Works Assoc.
Committee.

November 23, 1916.

At the meeting held on December 14, 1916, which was presided over by Mr. Leonard Metcalf, President of the American Water Works Association, there were present, in addition to the presiding officer, the following:

Representatives of the New England Water Works Association: Frank Barbour, Wm. R. Conard, Thomas H. Wiggin.

Representatives of the American Water Works Association: John H. Gregory, Frank A. Barbour, W. H. Randall, N. F. S. Russell, Walter Wood.

Representatives of Manufacturers: N. F. S. Russell, U. S. C. I. Pipe and Foundry Company; Walter Wood, R. D. Wood & Co.; S. B. Brown, Warren Foundry Company; S. H. Morrison, Warren Foundry Company; R. W. Conrow, Central Foundry Company; R. R. Rust, Central Foundry Company.

The important changes from the present standard specifications proposed by the Tentative Draft of Revised Specifications, and which were the subject of discussion in the meeting of December 14, 1916, are as follows:

1. The adoption of a uniform outside diameter for all classes of pipe of the same size.

2. The specification of the permissible range of total carbon, combined carbon, silicon, manganese, phosphorus and sulphur in the metal.

3. The requirement of a relation between flexure and breaking load in test bars.

Other less important revisions included more complete specification for coating, the including of the element of time in the hydro-

static test requirements, the addition of flanged pipe and the substitution of the word "fittings" for special castings.

After a prolonged discussion of the proposal to adopt a uniform outside diameter and of the feasibility of specifying chemical quality of the metal—the stenographic report of which covers 128 typewritten pages—it became evident that the manufacturers, as represented at the meeting, were opposed to the revision of the present specifications, for various reasons, including the expense incident to changes in present equipment, increased manufacturing difficulties and the belief that the present specifications were good enough. In order that the statements of the manufacturers as to the effect of the proposed changes on cost of production and on the technique of manufacturing might be supported by definite figures and arguments, the following motion was unanimously carried:

Moved that the manufacturers be requested to consider the tentative specifications for cast iron pipe as prepared and submitted to the manufacturers under date of May 7, 1916, and report to the Committee at a meeting to be held on March 15, 1917, the result of their deliberations, with such modifications of the specifications, paragraph by paragraph, as may seem to them desirable, together with their reasons therefor.

It was the understanding of those present that the manufacturers would discuss in detail the tentative revised specifications, and would present in writing at the meeting to be held on March 15, 1917, the results of their deliberations.

When the date of this meeting approached, it was found that the manufacturers were not prepared to submit any detailed discussion of the tentative draft of specifications, and on March 31st the following letter was received by the Chairman of your committee:

JOHN H. GREGORY, *Chairman, Committee on Cast Iron Pipe Specifications, American Water Works Association, 170 Broadway, New York City.*

DEAR SIR: Referring to the request of the committee that the manufacturers should again study the tentative specifications submitted by the joint committee of the American Water Works and New England Water Works Associations, and if necessary to propose their own specifications:

We beg to state that this question has been fully discussed at three meetings of the Manufacturers, and it is the unanimous opinion that there are no essential changes, at the present, necessary in the specifications of the American Water Works Association, adopted May 12, 1908.

These specifications are not ideal, but, for practically ten years, have proven fairly satisfactory to both user and manufacturer, as evidenced by their almost universal adoption.

We would, therefore, respectfully suggest that the Specifications of the American Water Works Association, as now drafted, remain unchanged.

Yours very truly,

[SIGNED] WALTER WOOD
N. F. S. RUSSELL.

The preceding letter makes evident the position of the manufacturers and the fact that not only will they not agree to any changes in the present specifications until forced to do so by the demand of consumers, but they will not coöperate with your committee to the extent of furnishing detailed reasons and figures in support of their objections to the proposed revision. Under these circumstances the only course open to your committee is to submit to the membership the tentative draft of revised specifications, and to request that after a reasonable time a ballot be taken to determine whether the Association is in favor of the adoption of the important changes suggested by these revised specifications:—viz., a uniform outside diameter, chemical requirements of the metal and a relation between flexure and breaking load.

To this end we recommend that the tentative draft of the revised specifications be printed and distributed to the members. The present draft of revised specifications is submitted to the Association for the purpose of ascertaining whether your committee is working along lines approved by the membership and there will doubtless be material modification in the present draft before final form is reached. It is not proposed that after final adoption the new specifications should go into effect for a number of years.

Presumably the New England Water Works Committee will follow the same course as suggested in this report, and will submit the revised specifications to that Association for its consideration.

It is obvious that in view of the manufacturers dictum that the present specifications are good enough, any further work on the part of your committee must be determined by the action of the Association. Presumably there was some reason for the appointment of this committee, and if in the judgment of the Association, there still remains sufficient reason for a revision of the specifications, doubtless the manufacturers will meet any reasonable requirements which may be demanded, but it is to be pointed out that all members should give serious consideration to the proposed revision, and should be prepared to follow up any vote in favor of revising the present specifications by a determination to use only the revised

specifications in their future work. It is believed that if, by coöperation with the New England Water Works Association and other similar bodies, a single standard specification can be developed, the result will be to the advantage of all concerned, including both the users and the manufacturers.

Respectfully submitted,
JOHN H. GREGORY, *Chairman*,
EDWARD E. WALL,
W. H. RANDALL,
F. A. BARBOUR.

May 11, 1917.

SOCIETY AFFAIRS

ANNUAL CONVENTION

The Constitution of the Association stipulates that each annual convention must open at 9 a.m., on a Tuesday. The program for the 1917 convention was so long, however, that in order to provide time for the technical meetings and the entertainments which were considered desirable, a preliminary gathering of the Association was held at the Jefferson Hotel, Richmond, Va., the convention headquarters and meeting place, at 8.30 p.m., May 7. President Metcalf was in the chair, and after calling the meeting together delivered the presidential address, printed on page 267 of this issue. At its close he introduced R. E. Milligan, who outlined the features of the entertainments provided by the Water Works Manufacturers Association and in the name of that organization presented to the American Water Works Association two silver cups as prizes in the annual golf tournament. One was a large cup to be contested for annually and remain for a year in the possession of the winner of the tournament at the beginning of that year, whose name will be engraved on it, and the other was a small cup of the same shape which remains permanently in the possession of the winner of the 1917 match.

Tuesday Morning, May 8, 1917. The thirty-seventh annual convention was called to order at 9 a.m. by President Metcalf, and during the session Mayor George Ainslee made a brief address of welcome to the city. The following papers were presented at this session:

"Recent Progress and Tendencies in Municipal Water Supply in the United States," by John W. Alvord, discussion by Rudolph Hering and Francis F. Longley.

"Concrete in Water Works Structures with Special Reference to Its Resistance to Weathering and Methods of Repairing It," by Rudolph J. Wig; discussion by Francis F. Longley, J. M. Diven, J. N. Chester, Rudolph Hering, Frank A. Barbour, N. T. Veatch, Jr., and the author. On motion of J. W. Alvord, acting for the

Publication Committee, the Association passed a vote of thanks to the author, who is not a member, for preparing and presenting the paper at the convention at the Committee's request.

"The Treasury Department Standard for Drinking Water; Its Value and Enforcement," by H. P. Letton, presented in the author's absence by Robert Spurr Weston; discussion by Robert Spurr Weston, John W. Alvord, F. W. Cappelen, Edward Bartow, Lewis I. Birdsall, Mayo Tolman, Chester G. Wigley, J. N. Chester and Leonard Metcalf.

The report of the Canvassing Committee was presented, as follows:

TROY, N. Y., April 28, 1917.

Your committee, appointed by Mr. Leonard Metcalf, President, to count the ballots for officers for the ensuing year, beg leave to report as follows:

Total number of ballots received	708
Total number of votes cast for President	706
For Mr. Theodore A. Leisen	597
For Mr. Chas. R. Henderson	109
Total number of votes cast for Vice-President	701
For Mr. Chas. R. Henderson	334
For Mr. Allan W. Cuddeback	367
Total number of votes cast for Treasurer	703
For Mr. James M. Caird	541
For Mr. A. A. Reimer	162
Total number of votes cast for Trustees	1403
For Mr. Beekman C. Little	640
For Mr. Henry B. Morgan	370
For Mr. W. S. Cramer	393

Six ballots were received in envelopes without the senders' names and were from cities having several members so could not be placed and were not opened or counted.

Respectfully submitted,

GEORGE P. HALFIN,
JAMES H. CALDWELL,
J. M. DIVEN, *Secretary*
Committee.

The officers-elect were introduced by President Metcalf and each made brief remarks.

Tuesday afternoon, May 8, 1917. The meeting was called to order at 2 o'clock by President Metcalf. The following papers were presented:

"Reliability of Pumping Station Design," by Clarence Goldsmith; discussion by Carleton E. Davis, J. N. Chester, F. W. Cappelen and the author.

Improved Efficiency of the St. Louis Pumping Stations," by Leonard A. Day; discussion by John C. Trautwine, Jr., J. N. Chester, Carleton E. Davis, R. B. Howell and the author.

"Pumping in the Metropolitan Water District of Massachusetts," by A. O. Doane; discussion by Carleton E. Davis, Charles R. Henderson, J. N. Chester, R. B. Howell and the author.

"Pumping Station Cost and Efficiency Records," by Mark Wolff, read by J. M. Goodell; discussion by Theodore A. Leisen.

"Relations between Water Departments, Companies and the Public," by W. C. Hawley; read by Robert Spurr Weston.

"Relations between a Water Department and the Public," by A. A. Reimer; read by J. M. Goodell.

Wednesday Morning, May 9, 1917. The meeting was called to order by President Metcalf and during the session Dr. Ernest C. Levy, formerly health officer of Richmond, was invited to address the Association. He explained the general features of the water supply of the city and its treatment by sedimentation and coagulation. The following papers were presented at this session:

"The New Charter of the Clarksburg Water Board," by Scotland G. Highland.

"Some Practical Points in Filter Plant Operation," by Lewis I. Birdsall; discussion by J. M. Diven, Edward Bartow, Joseph Race, C. Arthur Brown, Mayo Tolman, Theodore A. Leisen and the author.

"Decarbonation and Removal of Iron and Manganese from Ground Water at Lowell, Mass.," by Frank A. Barbour, printed in the JOURNAL for June, 1917; discussion by Samuel B. Applebaum, Edward Bartow, Robert Spurr Weston, Joseph Race and the author.

The chair announced that the cup offered last year by ex-President Hill for the largest percentage of increase in membership shown by any section had been won by the Minnesota Section, of which F. W. Cappelen is chairman and Lewis I. Birdsall is chairman of the membership committee. This section increased its membership from 20 to 29, an increase of 45 per cent.

The chair presented for the Executive Committee a resolution regarding the effect of mobilization on the operation of water works

plants; the discussion of this subject was continued to the sessions of Thursday morning and afternoon.

The following Nominating Committee was elected: District 1, Robert Spurr Weston; District 2, Charles R. Wood; District 3, James A. Steele, Jr.; District 4, John W. Alvord; District 5, H. Hymmen.

The Association voted to hold the next annual convention at St. Louis; Detroit, Mich., and Evansville, Ind., were the competing places.

Wednesday evening, May 9, 1917. The meeting was called to order by President Metcalf. The following papers were presented:

"History, Prices and Depreciation of Cast Iron Pipe," by B. B. Hodgman; discussion by J. M. Diven, A. F. Kirstein, J. N. Chester, George A. Main, Rudolph Hering, Charles F. Barrett, Leonard Metcalf, E. E. Davis and the author.

"Experience with Submerged Pipe Line in the Puerto Barrios Water Works," by T. Howard Barnes, presented by J. M. Goodell; printed in "Journal" for June, 1917.

"Troubles in Constructing a 48 inch Submerged Main," by F. W. Cappelen.

"The Effect of Covering a Service Reservoir," by John Gaub, presented by J. M. Goodell.

Thursday morning, June 10, 1917, Superintendents' Session. The meeting was called to order by President Metcalf. The following papers were presented:

"Thawing Frozen Water Mains by Electricity," separate papers by Henry B. Machen, and W. I. McMane; discussion by E. J. Jenkins, Theodore A. Leisen, J. Walter Ackerman, G O. House, C. W. Wiles, E. H. Breidenbach, Frank C. Kimball, R. F. Johnson, R. A. Jackson B. F. Stedman, R. B. Howell, Charles F. Barrett, J. M. Diven, A. W. Cuddeback, H. F. Huy, Patrick Gear, Robert L. Clemmitt and Henry B. Machen.

"Trenching Machine Work," by W. W. Brush; discussion by Theodore A. Leisen, J. M. Diven, C. W. Wiles. A. W. Cuddeback, William Luscombe, E. E. Davis R. B. Howell Leonard Metcalf, M. N. Baker, A. Prescott Folwell, Robert Elliott, H. V. Knouse, George G. Earl, Dow R. Gwinn, J. M. Higbie and the author.

The report of the Committee on Specifications for Cast Iron Pipe and Specials was presented in the absence of the chairman by F. A. Barbour, and discussed by Theodore A. Leisen, J. M. Diven

and F. A. Barbour; it was presented out of its order on the official program and further discussion was postponed until the session of Friday morning.

Thursday morning, May 10, 1917, Chemical and Bacteriological Section. The meeting was called to order at 9 o'clock by the chairman of the section, Charles P. Hoover. The minutes of the last meeting were read and approved. The following papers were presented:

"Water Supply Standards and Their Improvement," by Wm. J. Orchard; discussion by Chester G. Wigley, F. W. Green, George R. Taylor, Lewis I. Birdsall, Joseph Race, J. Y. Cheney, Edward Bartow and the author.

Following this discussion, there was a discussion of the advisability of having the operating officials of water purification plants represented by a committee of the American Water Works Association, which would participate if possible in any discussions which other organizations, such as the American Public Health Association, may hold regarding standard requirements for the quality of water, and would have, if possible, some voice in any standardization of methods of water analysis.

"The Differentiation of Bacteria of the Colon-Aerogenes Family," by William Mansfield Clark; discussion by Edward Bartow, Joseph Race, F. W. Green and the author.

"The Quality of Water and Confirmatory Tests for B. Coli," by Abel Wolman, presented by J. A. Kienle, printed in the JOURNAL for June, 1917; discussion by W. J. Orchard.

Thursday afternoon, May 10, 1917, Superintendent's Session. The meeting was called to order by President Metcalf. The following papers were read:

"Leakage from Vitrified Pipe Used to Convey Water under a Low Head," by William W. Brush; discussion by J. Y. Cheney and the author.

"Forty-five Years Experience in Water Works Service," by E. E. Davis; discussion by Leonard Metcalf, J. M. Diven, Henry P. Bohmann and the author.

"Leakage from High-Pressure Fire Service Mains," by Henry B. Machen; discussion by Leonard Metcalf, J. Walter Ackerman and the author.

"Funding Sanitary Improvements as a Means of Increasing Water Consumption," by R. A. Butler and F. C. Jordan; discussion

by J. M. Diven, J. N. Chester, J. Walter Ackerman, William Luscombe, M. N. Baker, M. L. Worrell, C. D. Brown, W. A. Patton, A. F. Kirstein, F. C. Kimball and F. C. Jordan.

"Lead Wool," by R. J. Thomas, read by J. M. Goodell; discussion by J. M. Diven and A. W. Cuddeback.

Two subjects for informal discussion were furnished by the Question Box, as follows: "Where funded water works debts and interest accounts are taken care of by the city council and paid from general funds should the water works books show these items?," discussed by W. W. Brush, Leonard Metcalf, J. Walter Ackerman, George A. Main, Henry P. Bohmann, William Luscombe, Frank A. Kimball, and R. B. Howell; "Reasons for and disadvantages of recarbonation of water softened by the lime-soda process, and the cost of recarbonation where tried," discussed by F. A. Barbour and George A. Main.

Thursday afternoon, May 10, 1917, Chemical and Bacteriological Section. The meeting was called to order by the chairman, Charles P. Hoover. The following papers were presented:

"Manganese in Water Supplies," by Edward Bartow and H. P. Corson, presented by the former; discussion by C. A. Haskins, N. T. Veatch, Jr., S. B. Applebaum and Edward Bartow.

"The Chlorine Cell Installation of the Montreal Water and Power Company," by F. H. Pitcher and James O. Meadows; discussion by Lewis I. Birdsall, S. B. Applebaum, Mayo Tolman and F. H. Pitcher.

"Chlorine Treatment at Ottawa, Canada," by Joseph Race; discussion by Lewis I. Birdsall, W. J. Orchard and the author.

A topical discussion on one of the subjects in the Question Box of the Superintendents' Session was taken up: "Reasons for and disadvantages of recarbonation of water softened by the lime-soda process and the cost of recarbonation where tried."

As a result of the discussion at the morning session and conferences with the president and secretary of the Association, it was voted to recommend to the president of the Association the appointment of a committee to consider

(A) Official Standards of Water Analysis:

1. Interpretation.
2. Methods.
3. Feasibility of coöperation with other organizations.

(B) Means for placing the recommendations before the Association and the general public.

The chairman announced that he would recommend to the president the appointment on such committee of W. J. Orchard, C. A. Haskins, Edward Bartow, Joseph Race and Robert B. Morse.

The election of Section officers for the ensuing year was then held, resulting in the following choice: Chairman, August V. Graf; secretary, J. A. Kienle; executive committee, Lewis I. Birdsall, C. A. Haskins and Richard Messer.

Thursday afternoon, May 10, 1917, Special session. At 4 o'clock the business of the general meeting and of the Chemical and Bacteriological Section was interrupted by previous arrangement in order to complete the discussion of the action to be taken by the Association in view of war conditions. The following resolution was unanimously adopted:

> *Resolved,* That the American Water Works Association, assembled in annual convention, pledges its readiness to serve the national government in such manner as may be most helpful in the present national crisis.

This resolution was telegraphed to President Wilson later in the day.

Thursday evening, May 10, 1917 The meeting was called to order by President Metcalf. The following papers were presented:

"Methods of Determining and Plotting Meter Capacities and some Results," by Fred B. Nelson.

"Lowering Ground Water Levels," by Clarence L. Kirk; discussion by John W. Alvord, W. W. Brush, Dabney H. Maury, George A. Main, Leonard Metcalf, A. Prescott Folwell and the author.

"Experiences and Experiments with Wrought Iron and Steel Service Pipe," by Alexander Milne; presented by title in the absence of the author, owing to the crowded condition of the session's program.

The report of the Secretary was read by J. M. Diven; the Association voted to receive it and place it on file. It is printed on page 405.

The report of the Treasurer was read by James M. Caird; the Association voted to receive it and place it on file. It is printed on page 408.

The report of the Finance Committee, printed on page 409, was submitted by Henry B. Morgan, who supplemented it by a review

of the financial progress of the Association since 1910, attributing most of the success of the Committee to the work of the retiring chairman, H. H. Keeler. On motion by Mr. Morgan, seconded by J. M. Diven, the Association passed a vote of thanks to Mr. Keeler for his work in behalf of the Association and instructed the Secretary to forward a copy of this action to Mr. Keeler.

President-elect Leisen reported for the Executive Committee that it recommended the adoption of the budget proposed by the Finance Committee with the exception of the item fo the JOURNAL, which it advised increasing from $5,000 to $5,500 because the Editor believed there would be a material increase in the cost of printing and mailing the publication during the year. The action of the Finance Committee in authorizing the overdraft of three items in the budget for the past year was approved and the budget recommended for the new year was adopted with an increase of the item for the JOURNAL from $5000 to $5500.

An informal report was made for the Publication Committee by John W. Alvord, chairman. On motion by Dabney H. Maury, seconded by J. M. Diven, a vote of thanks was passed to Mr. Alvord for his services on this committee. An abstract of the stenographer's report of Mr. Alvord's statement is printed on page 412.

The Committee on Electrolysis presented majority and minority reports. On motion by Charles R. Henderson seconded by Henry B. Morgan, both reports were ordered printed, discussion of them was deferred to the next convention, and the members of the committee were discharged. The reports are printed on page 386.

No report was received from the Committee on the Revision of the Constitution. It was moved by Dabney H. Maury and seconded by Charles R. Henderson, members of the committee, that the committee be discharged in order that the incoming President might appoint a special advisory committee to the Executive Committee to act upon suggested changes to the Constitution; this motion was carried.

No report was submitted by the Committee on Standard Specifications for Hydrants and Valves. J. M. Diven stated for the committee that it submitted a final report at the last convention but was continued to endeavor to prepare specifications for light-weight valves, which the committee found to be impracticable. On motion by M. L. Worrell, seconded by Henry B. Morgan, the Association voted to discontinue the committee.

During the discussion on the methods to be followed in the revision of the Constitution, the Association voted, on motion by Henry B. Morgan, that a report of the discussion regarding the nomination of Charles H. Henderson for president, edited for brevity, should be printed and distributed to the members. It is printed in a supplement to this number of the JOURNAL.

Friday morning, May 11, 1917. The meeting was called to order by President Metcalf.

Theodore A. Leisen presented for the Committee on the Prevention of the Pollution of Streams and Lakes a report which is printed on page 383. The report was accepted and the committee discharged.

Nicholas S. Hill, Jr., stated for the Committee on Private Fire Protection Service that its report would be ready shortly. The Association voted that as soon as the report was ready it be printed in pamphlet form and distributed as a supplement to the JOURNAL.

The Committee on City Planning submitted a report accompanied by a large number of photographs, shown to the convention by lantern slides. The Association voted to continue the committee.

Edward S. Cole presented for the Committee on Water Consumption a report which is printed on page 378. The Association voted to adopt the report of the committee, and to distribute leaflets to the members embodying the form recommended by the committee and urge the adoption of the form by water departments. The President ruled that this action carried with it the appointment of a new committee as recommended in the report.

Nicholas S. Hill, Jr., presented an informal progress report of the Committee on the Classification of Technical Literature. The Association voted to continue the committee.

The discussion of the report of the Committee on the Revision of the Standard Specifications for Cast Iron Pipe and Specials was continued from Superintendents' Session on Thursday morning. It was voted to continue the committee and to authorize it to send out such questions to the members as were needed to enable it to ascertain the sentiment of the Association with regard to changes in the specifications.

The report of the Executive Committee was presented by President Metcalf. It is printed on page 404. The report was accepted.

The report of the Committee on Depreciation was presented by the chairman, John W. Alvord, and a dissenting opinion regarding a portion of the report was presented by J. N. Hazlehurst. On motion

of Mr. Alvord, seconded by Dabney H. Maury, it was voted to print the report of the committee and the dissenting opinion of Mr. Hazlehurst and distribute them to the Association as soon as practicable, with a statement that the report and dissenting opinion were open for written discussion; and to request the Executive Committee to give an opportunity for a full discussion of the report and dissenting opinion at the next annual convention; and to discharge the committee with permission to make a closure to the discussion.

During the session a silver tea service, comprising a salver and five pieces, was presented to E. E. Davis by President Metcalf as evidence of the appreciation of his valued work in the Association for many years and of the affectionate regard in which he was held by several hundred of the active and associate members of the Association.

REPORT OF EXECUTIVE COMMITTEE

RICHMOND, VA., May 11, 1917.

The Executive Committee begs leave to report for the year 1916–1917 as follows:

J. M. Diven was reëlected secretary and H. E. Keeler chairman of the Finance Committee of the Association.

With the approval of the Secretary and of the Publication and Finance Committees, the secretarial and editorial work of the Association was separated. The Executive Committee secured the services of John M. Goodell as editor.

The League to Enforce Peace offered the coöperation of its staff of lecturers, headed by ex-President Taft, at the 1917 convention. The Executive Committee decided that the program was too full of strictly water works discussions to permit the introduction of unrelated subjects, however important they might be. The committee also decided that public discussion of the guarding of water works was undesirable.

The formation of a California Section has been authorized.

The Executive Committee authorized the appointment by the President of a special committee to consider amendments to the Constitution; this committee to report to the Executive Committee not later than September 15 and the Executive Committee to report to the Association not later than December 1, 1917.

The Executive Committee voted to recommend the election to honorary membership by the Association of S. J. Rosamond, of Fort Smith, Arkansas.

For the Executive Committee,

LEONARD METCALF,
President.

SECRETARY'S REPORT FOR YEAR ENDING MARCH 31, 1917

Financial statement

Cash on hand April 1, 1916		$3,115.06
Receipts:		
Initiation Fees		910.00
Annual Dues		7,425.40
Advertisements in Journal		2,399.36
Sales of Journal		74.75
Sales of Proceedings		127.00
Exchange on Checks		.07
Interest on Deposits		117.12
Interest on Investments		383.40
Subscriptions for Journal		267.50
Authors copies of papers		17.43
Hydrant and Valve Specifications		8.20
Jordan Reports		3.75
Special Contributions		25.00
Binding Cases 1914 Journal		.65
Binding Cases 1915 Journal		25.75
Pipe Specifications		48.95
		$14,949.39
Disbursements:		
Office Expenses	$619.29	
Convention Expenses	814.28	
Typhoid Toll	44.89	
Printing Journal	4,963.81	
Committee Expenses	391.62	
Salary of Secretary	1,712.50	
Salary of Editor	233.33	
Binding Cases 1916	81.79	
Election Expenses	124.54	
Rent of Storeroom	50.00	
Insurance, fire and liability	31.22	
Association Badges	24.00	

Advertising	$186.46	
Section Expenses	409.30	
Invested in Bonds	2,000.00	$11,687.03
Cash on hand March 31, 1917		$3,262.36
Cash on hand April 1, 1916*		1,115.06
Gain in cash resources		2,147.30

* Less investments.

	ALLOWANCE	EXPENDED	OVER	UNDER
Convention expenses	$700.00	$814.28	$114.28	$80.71
Office expenses and postage	700.00	619.29		80.71
Election expenses	75.00	124.54	49.54	
Committee expenses	400.00	391.62		8.38
Sections	500.00	409.30		90.70
Office equipment	50.00	.00		50.00
Insurance	50.00	31.22		18.78
Rent, store room	120.00	50.00		70.00
Salary, Secretary-Editor	1,800.00	1,945.83	145.83	
Printing and distributing JOURNAL	5,000.00	4,963.81		36.19
Contingencies	500.00	186.46		313.54
Totals	$9,895.00	$9,536.35	$309.65	$668.30
Total overdrawn				309.65
Net under budget				$358.65

Surplus from business of fiscal year ending March 31, 1917

Receipts:

Initiation Fees	$910.00
Annual Dues	7,425.40
Advertisements in Journal	2,399.36
Sales of Journal	74.75
Sales of Proceedings	127.00
Exchange on Checks	.07
Interest on Deposits	117.12
Interest on Investments	383.40
Subscriptions to Journal	267.50
Authors copies of papers*	9.51
Hydrant and Valve Specifications	8.20
Jordan Reports	3.75
Special Contributions	25.00
Binding Cases—profit on 1914	5.05
Binding Cases—profits on 1915	7.25
Pipe Specifications	48.95
Total Receipts	$11,812.31

Expenses:

Office Expenses	$619.29	
Convention Expenses	814.28	
Printing Journal	4,963.81	
Committee Expenses†	391.62	
Salary of Secretary	1,712.50	
Salary of Editor‡	233.33	
Election Expenses§	124.54	
Rent, Store Room	50.00	
Insurance, fire and liability	31.22	
Contingencies, advertising for members‖	186.46	
Section Expenses	409.30	
Total Expenses		$9,536.35
Net Surplus		$2,275.96

* Authors' Copies of Papers 7.92 carried over, received for reprints for March, 1917, Journal and not yet paid for.

† Included $200 for the American Committee on Electrolysis.

‡ Salary of Editor 3½ months; of Secretary 3½ months at $1800, 3½ months at $1500 a year.

§ Owing to earlier date of convention expenses of part of two years included.

‖ Expenses of Four States Sections for two years; no expense for Central States Section.

Membership Statement

This report is made up as of April 1st, contrary to the usual method, which was to make the membership report as of the convention year, thus crediting to each administration the work of its term. The change was made this year in accordance with a resolution of the Executive Committee:

Elected since last report:

Active			72	
Corporate			3	
Associate			6	
			—	82

Losses:

Resigned—	Active	31			
	Corporate	3			
	Associate	3	37		
Died—	Active		10		
Suspended—	Active	43			
	Corporate	3			
	Associate	2	48		95
		—	—		—
				Loss	13

Membership	Last Rpt.	Apr. 1, 1917	Gain:	Loss:
Active	1150	1139		11
Corporate	81	78		3
Associate	123	124	1	
Honorary	7	7		
	1361	1349	1	14
			Net Loss,	13

Respectfully submitted,
J. M. DIVEN,
Secretary.

TREASURER'S REPORT FOR THE YEAR ENDING MARCH 31, 1917

TROY, N. Y., April 2nd, 1917.

The Executive Committee and Members American Water Works Association.

GENTLEMEN:-Permit me to submit my report as Treasurer of the American Water Works Association for the year ending March 31, 1917.

The funds of the Association are on deposit with the Troy Trust Company, Troy, N. Y.

Receipts during the year were as follows:

Balance April 1, 1916	$3,124.96
Received from J. M. Diven, Secretary	12,790.74
Interest on deposits	117.12
Interest on investments	216.66
Profit, exchange of securities	209.24
Total	$16,458.72
Disbursements, as per vouchers, cancelled checks and debit slips	13,196.36
Balance April 1, 1917	$3,262.36

Certificate of the Troy Trust Company shows a deposit of $3,381.64 at close of business March 31, 1917. From this balance should be deducted the following for unreturned checks:

Deposit as per certificate		$3,381.64
V. 702, Ck. 872, Brush	$11.40	
V. 707, Ck. 877, Bartow	73.13	
V. 709. Ck. 879, Wood	34.75	119.28
Balance		$3,262.36

The receipted vouchers, cancelled checks and debit slips with book of the Treasurer are submitted for audit.

During the year the permanent fund was increased by an investment of the par value of $2000.

The permanent fund now consists of investments of the par value of $6000, as follows:

4 $1000 Dominion of Canada 5%, 15 Year Bonds	$4,000.00
2 $1000 American Foreign Security Co. 5%, 3 yr. notes (M31719–M31720)	2,000.00
Par value of Permanent Fund	$6,000.00

It is to be hoped that the financial condition of the Association will be such during the coming year that the amount of the permanent fund can be increased.

The Treasurer is under $5000 Bond as per order of your committee.

Respectfully submitted,

JAMES M. CAIRD,
Treasurer.

REPORT OF THE FINANCE COMMITTEE FOR THE YEAR ENDING MARCH 31, 1917

Your Finance Committee would most respectfully report as follows:

We have audited the books of the Secretary and Treasurer, and we find them to be correct. We have examined and verified the vouchers and they are correct.

We are pleased to submit, for your information, the following statement of the financial operations of the Association for the past fiscal year:

Amount of cash on hand in bank, to the credit of the Association, April 1, 1916	$3,124.96	
There was received, according to the Treasurer's report, from the Secretary	$12,790.74	
There was received, account of interest on deposits and on investments of permanent fund	333.78	
There was received by the Treasurer, on account of exchange in securities	209.24	
Total		$16,458.72

There has been disbursed and paid, by the Treasurer, on vouchers duly authorized and audited by the Finance Committee, for the general operations of the Association	$11,196.36	
There has been added to the permanent investment fund, the sum of	2,000.00	
Total		$13,196.36
There was on deposit, to the credit of the Association, in the bank, the sum of		$3,262.36

There are now in the hands of the Treasurer, in accordance with the authority granted to the Finance Committee by the Executive Committee, bonds of a par value of $6000 consisting of the following securities:

Four $1000 Dominion of Canada, 15 year bonds, due April 1, 1931	$4,000.00	
Two $1000 American Foreign Securities Company's 3 year bonds, or notes, due August 1, 1919	2,000.00	
Total		$6,000.00

All of these securities bear 5 per cent interest per annum.

The Finance Committee, in compliance with suggestion received from the Executive Committee, have subscribed for $2000, 3½ per cent United States War Loan bonds which will be paid for from the present surplus when said bonds are issued and ready for delivery.

The Treasurer is under $5000 bonds at the present time and it is recommended that his bond be increased to $10,000.

You will find the details of the financial operations of the Association and the various funds and accounts, as per their books, fully described and referred to in the report of the Secretary and Treasurer.

You will note from the Secretary's report that the budget adopted for the last fiscal year amounted to $9895. That there was charged against it $9536.35. There were three items, namely—Convention Expenses, Election Expenses, and Salaries, where it was necessary to slightly overdraw the amount appropriated and we ask that our action in thus overdrawing be ratified and approved. Part of this was caused by the separation of the office of the Secretary and Editor and part caused by the unusually large Convention expenses for the New York Convention.

Your committee recommends that the following budget be adopted for the fiscal year 1917 and 1918:

(1) Convention expenses	$800.00
(2) Office expenses and postage	800.00
(3) Election expense	100.00
(4) Committee expenses	600.00
(5) Sections	500.00
(6) Insurance	75.00
(7) Salary of secretary	1,500.00
(8) Salary of editor	800.00
(9) Printing and distribution of JOURNAL	5,000.00
(10) Contingencies	500.00
Total	$10,675.00

Our average receipts, which we have every reason to believe will be maintained, are about $12,000 per annum.

Your committee note a very considerable expenditure, the past year, by a committee to visit the city selected for holding the next convention. We recommend that such a committee and expenditure be discontinued.

The Association (as of the first of April, the beginning of the fiscal year) is to be congratulated on the fact that it starts out with a substantial cash balance and with a very moderate amount of unpaid bills incurred during the last fiscal year, which bills were received too late to be properly audited, all of which have since been vouchered and paid.

The Secretary's report, to which we call your attention, shows, on his trial balance, the exact financial condition of the Association and it is one that we all have reason to be proud of.

Your committee is pleased to again report the active coöperation of all the officers of the Association and that its books and accounts are in excellent condition.

Respectfully submitted,

H. E. KEELER,
H. A. DILL,
HENRY B. MORGAN.

REPORT OF PUBLICATION COMMITTEE FOR THE YEAR 1916–1917[1]

The Publication Committee has little to report. But they usually have a great deal to do. It is a long, cold day in January when the Publication Committee is not in hot water with somebody or other; and each year seems to keep up its friction average with the year before. As an instance of this I may say that I destroy from my files a pile of letters each year about half a foot to a foot deep, all matters which the Publication Committee had to correspond about during the year; letters from outraged authors, from people who resented having their manuscript tri nmed, and most largely of all letters containing long and profitless discussions with our worthy Secretary over the Society printing policies.

This year the Executive Co nmittee, in response to the request of the Publication Co nmittee, have appointed an Editor who I think is in accord with the general policy which the Publication Committee have had in mind for the past ten years; and we feel that the Publication Committee's work is therefore going to be reduced. One peculiar condition, however, always exists; when the Editor gets abused he conveniently lays it on the Publication Committee, and when the Publication Committee get abused they conveniently lay the blame on the Editor. This situation, however, is usually fully understood between the Editor and the Committee and outside of that the Publication Committee will probably have less to do in the coming year, now that they have an Editor.

With this latest determination of the rather prolonged difference of opinion as to policy between the Publication Committee and the Secretary of the Society, I have felt that the opportunity has come for me to withdraw from the chairmanship of the Publication Committee. I have looked for such opportunity for several years, but the situation did not seem to come to such a condition of financial security for the society that I felt justified in letting go. I understand from what I hear that this last election has been fought out on the theory that some of us out there in Chicago are having too much to do with the control of the Society. I admit that this charge is true. We have had the Society's interests so much on

[1]Instead of making a formal report, the chairman of the committee, John W. Alvord, made a verbal report, which is printed as revised by him as an expression of the views of all members of the committee.

our minds, so much in our hearts, that we probably have stayed in office too long, and probably have entered into too many controversies, rolled up probably too many irritated opponents; and I only mention this because I would have been glad to withdraw several years ago had the way seemed perfectly clear.

Now just one more word as a caution to whomsoever takes up this work of Publication. Ten years ago, when I was honored by being elected President at New Orleans, the Society was in debt and it was the third time that it really had been in debt and that the hat had been passed around to make up a deficiency. At New Orleans we were in serious financial difficulty, and we were all concerned to know how such a condition was going to be avoided in the future. The analysis that I made of the situation at that time, in company with Mr. H. E. Keeler, Chairman of the Finance Committee, was that prolific printing was always the cause of our financial troubles and if prolific printing were not curtailed we would be in debt continuously. The whole secret of the matter lay in trimming the *Proceedings* of the Association down to a reasonable quantity and good quality, and keeping them within the means of the Society.

As the Chairman of the Publication Committee I attempted to do that work. I have tried to do it considerately and I think the financial reports which have been made here to-night have amply demonstrated that it has been done. We have never been in debt since that time. We have kept the *Proceedings* within limits. The very first year that I was elected President I took the whole matter into my own hands and cut the *Proceedings* from a volume $2\frac{1}{2}$ inches thick to one about an inch, or less than an inch, thick.

The contributions to lift the debt gave us our start, after which it was largely the work of the Finance and Publication Committees to trim the printing bill to an annual amount within our means. The Publication Committee have been a unit on that matter, and the Finance Committee have splendidly coöperated with the Publication Committee, so that we have worked together as one committee. It has been the endeavor of the Publication Committee not to print things which were useless to our records and which would not be valuable in the future to the Society, and to curtail matter down to that which the Society could well afford to print and thereby to keep our financial condition sound.

Now we have not always been successful in doing this and we have not used perfect judgment by any means; we have sometimes

let things get by us; sometimes we have offended good friends when perhaps a little more tact would not have offended them. Perhaps we have cut out things that should have been left in. But we have done the best we could, and we have attempted to keep the printing within the means of the Society. It is quite probable that the Society, with a larger membership and more income, will be able to print a little more than it did but it can never be extravagant and survive.

Now the policy of my good friend the Secretary of this Society and the former Editor of our JOURNAL has just been the opposite of that of the Publication Committee and he has never conceded for a moment that his policy was not a better policy than that of the Publication Committee. This has made it very hard and uncomfortable for us, and caused a great deal of useless discussion and correspondence. It has not been a matter of personality at all; we were all good friends under most of the stresses of it; but it has made it trying because all the way along we have had to contest that desire of the Editor to print anything that anybody would send in that looked as if it would make a good sized volume out of the annual number, and thereby keep everybody happy. We, on the other hand, by our policy of chopping off, eliminating, re-writing, have made many authors unhappy, so I do not wonder that in due course of all these seven or eight years we have been at this job we have rolled up quite a little ill-feeling in the aggregate, very much like a snow-ball rolls up on a soft winter day. But that has been one of the difficulties of the situation, that as between the Editor and the Publication Committee there have been two distinctly different attitudes toward the financial condition of the Society and toward printing expenditures particularly.

I do not think the *Proceedings* have suffered by curtailment, and I do not think, as we look back over them, that we will find that they are any less valuable; but you would be surprised if any of you were Chairman of the Publication Committee for a year or two, to see how many people want to exploit the Society in their own behalf in some way that is not in good taste or does not have a proper attitude toward the Society.

And with this very frank explanation of the work which I have felt compelled to carry on as a member of that Committee, I resign my position as Chairman of the Publication Committee, with the

hope that some one else more competent and more tactful than I have been will take it up—and will enjoy it and make more of a success of our *Proceedings*.

MINNESOTA SECTION

A meeting of the Minnesota Section was held at Minneapolis on April 21, 1917, the attendance being sixteen. The chairman of the Section, F. W. Cappelen, presided. The following papers were presented:

"Operation of the Minneapolis Water Purification Plant since 1913," by Lewis I. Birdsall; discussed by F. W. Cappelen, G. O. House, H. A. Whittaker, J. A. Childs and the author.

"Some Experiences with Centrifugal Pumps," by E. C. York; discussion by G. O. House, F. W. Cappelen, H. F. Blomquist and the author.

After the meeting a visit was made to the McCarron pumping station of the St. Paul water works and the new reservoir in connection with the proposed purification plant for that city.

NEW MEMBERS

Honorary Member

S. J. Rosamond, Brevard, N. C.

Active Members

M. M. Boyd, Superintendent Water Works, Spartanburg, S. C.

Herbert A. Claiborne, Contracting Engineer, 609 West Grace Street, Richmond, Va.

Richard J. Donnelly, Sanitary Engineer, 515 West 156th Street, New York, N. Y.

C. M. Dorway, Superintendent Water Works, Eveleth, Minn.

Archie Vail Duncanson, City Engineer's Office, Minneapolis, Minn.

E. H. Goodrich, Superintendent Water Works, Fredericksburg, Va.

J. William Griffin, Superintendent Water Department, 121 Garrison Avenue, Jersey City, N. J.

Edgar W. Johnson, Assistant Engineer, Water Department, 2632 Fourteenth Avenue South, Minneapolis, Minn.

John H. Lance, Chief Engineer, Spring Brook Water Supply Company, 30 North Franklin Street, Wilkes-Barre, Pa.

J. H. McGinty, Superintendent Water Works, Mansfield, Ohio.

W. E. MacDonald, City Water Works Engineer, 93 Powell Avenue, Ottawa, Canada.

A. J. Mahnkin, Civil and Sanitary Engineer, 52 Hudson Place, Weehawken, N. J.

S. J. Mason, Engineer and Superintendent Water Works, Perth Amboy, N. J.

J. W. Neave, Superintendent Water Works, Salisbury, N. C.

W. S. Patton, Secretary, Ashland Water Works Co., Ashland, Ky.

Malcolm Pirnie, Consulting Engineer, 30 East 42d Street, New York, N. Y.

S. P. Rees, Civil Engineer, 170 Sprague Avenue, Pittsburgh, Pa.

Bernard A. Ruge, Secretary-Treasurer, Ward Carpenter & Co., Tarrytown, N. Y.

F. M. Travis, President, Torrington Water Company, 77 Church Street, Torrington, Conn.

Lawrence C. Whitsit, City Engineer, 110 California Avenue, Highland Park, Mich.

Edward C. York, Chief Engineer Pumping Station, 3236 Portland Avenue, Minneapolis, Minn.

Corporate Members

Michigan State Board of Health, Lansing, Mich.

Water and Light Board, J. J. Rowan, Superintendent, 409 McKinley Street, Hibbing, Minn.

Associate Member

Central Brass Manufacturing Company, 6203 Cedar Avenue, Cleveland, Ohio.

DEATHS

Frederick T. Elwood, City Engineer, Rochester, N. Y.; died May, 1917.

Albert S. Glover, Secretary Hersey Manufacturing Company, Boston, Mass.; died, May 7, 1917.

Albert F. Ganz, Professor of Electrical Engineering, Stevens Institute, Hoboken, N. J.; died July 28, 1917.